PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-191280
(43)Date of publication of application : 17.07.2001

(51)Int.Cl. B25J 13/00
B25J 5/00
G05B 11/36
G05B 13/02

(21)Application number : 11-375547
(22)Date of filing : 28.12.1999

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(54) ROBOT DEVICE AND ITS CONTROLLING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To realize a robot device and its controlling method capable of greatly improving its amusement property.
SOLUTION: In the robot device having a plurality of leg parts and driving each of them according to a predetermined pattern to walk and its controlling method, the leg parts are driven so as to vary a walking pattern according to the degree of emotions matching an emotion model, so that the walking pattern can be changed according to a change in emotions in a specific phenomenon.

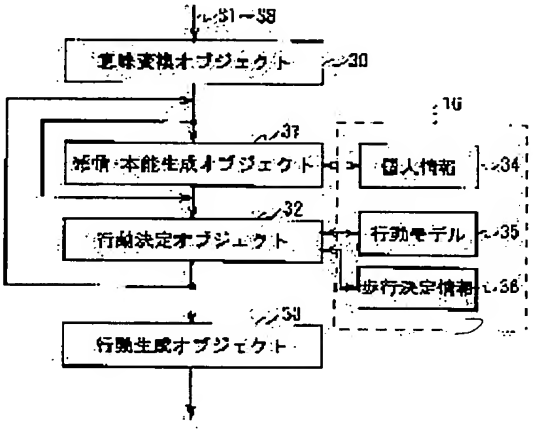

図3 ペットロボットの行動生成

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2001－191280
（P2001－191280A）
(43)公開日　平成13年７月17日(2001.7.17)

(51)Int.Cl.⁷		識別記号	FI		テーマコード(参考)
Ｂ２５Ｊ	13/00		Ｂ２５Ｊ	13/00	Ｚ　３Ｆ０５９
	5/00			5/00	Ｃ　３Ｆ０６０
Ｇ０５Ｂ	11/36	５０１	Ｇ０５Ｂ	11/36	５０１Ｆ　５Ｈ００４
	13/02			13/02	Ｚ　９Ａ００１

審査請求　未請求　請求項の数４　ＯＬ　（全 10 頁）

(21)出願番号　特願平11－375547

(22)出願日　平成11年12月28日(1999.12.28)

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最終頁に続く

(54)【発明の名称】　ロボット装置及びその制御方法

(57)【要約】
【課題】本発明は、アミューズメント性を格段と向上させ得るロボット装置及びその制御方法を実現しようとするものである。
【解決手段】複数の脚部を有し、各脚部を所定パターンで駆動するようにして歩行するロボット装置及びその制御方法において、感情モデルに応じた情動の度合いに応じて歩行のパターンを変化させるように各脚部を駆動するようにしたことにより、特定の事象において感情の変化に応じて歩行パターンを変化させることができる。

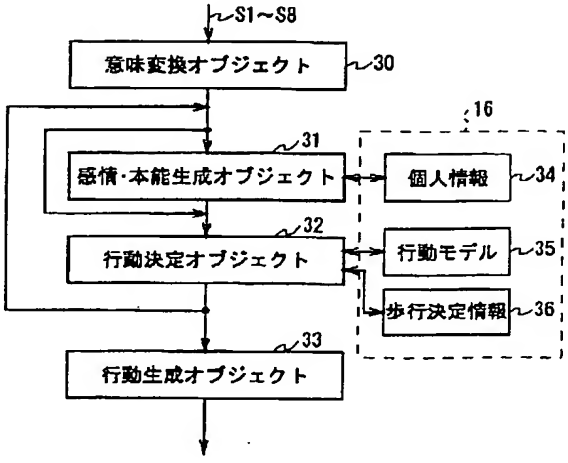

図３　ペットロボットの行動生成

1

【特許請求の範囲】

【請求項１】複数の脚部を有し、各上記脚部を所定パターンで駆動するようにして歩行するロボット装置において、

各上記脚部を駆動する駆動手段と、

感情モデルに応じた情動の度合いに応じて上記歩行のパターンを変化させるように上記駆動手段を制御する制御手段とを具えることを特徴とするロボット装置。

【請求項２】上記歩行のパターンは、上記情動の度合いに応じて段階的に変化することを特徴とする請求項１に記載のロボット装置。

【請求項３】複数の脚部を有し、各上記脚部を所定パターンで駆動するようにして歩行するロボット装置の制御方法において、

感情モデルに応じた情動の度合いに応じて上記歩行のパターンを変化させるように各上記脚部を駆動することを特徴とするロボット装置の制御方法。

【請求項４】上記歩行のパターンは、上記情動の度合いに応じて段階的に変化することを特徴とする請求項３に記載のロボット装置の制御方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はロボット装置及びその制御方法に関し、例えばペットロボットに適用して好適なものである。

【０００２】

【従来の技術】近年、ユーザからの指令や周囲の環境に応じて決まった動作を行う４足歩行型のペットロボットが本願特許出願人により提案及び開発されている。かかるペットロボットは、一般家庭において飼育する犬や猫に似た形状を有し、ユーザからの指令や周囲の環境などに応じて動作を行うものである。

【０００３】

【発明が解決しようとする課題】ところでかかるペットロボットにおいては、周囲の状況やユーザからの働きかけに応じて種々の感情を表現する機能を有している場合、比較的短時間で急激な感情の変化を表現することは行われているが、さらに比較的時間が必要とされる緩やかな感情の変化をその過程を踏まえて表現することができれば、より一層の親近感や満足感をユーザに与えて、ペットロボットとしてのアミューズメント性をより向上させることができるものと考えられる。

【０００４】特にこのような感情の緩やかな変化をペットロボットの歩行パターンを用いて表現することができれば、ユーザにとってペットロボットの感情表現が変化する過程が認識し易く、かつそれらの表現に多様性をもたせられると考えられる。

【０００５】本発明は以上の点を考慮してなされたもので、アミューズメント性を格段と向上させ得るロボット装置及びその制御方法を提案しようとするものである。

2

【０００６】

【課題を解決するための手段】かかる課題を解決するため本発明においては、複数の脚部を有し、各脚部を所定パターンで駆動するようにして歩行するロボット装置において、各脚部を駆動する駆動手段と、感情モデルに応じた情動の度合いに応じて歩行のパターンを変化させるように駆動手段を制御する制御手段と設けるようにした。

【０００７】この結果このペットロボットでは、特定の事象において感情の変化に応じて歩行パターンを変化させることができる。

【０００８】また本発明においては、複数の脚部を有し、各脚部を所定パターンで駆動するようにして歩行するロボット装置の制御方法において、感情モデルに応じた情動の度合いに応じて歩行のパターンを変化させるように各脚部を駆動するようにした。

【０００９】この結果このペットロボットでは、特定の事象において感情の変化に応じて歩行パターンを変化させることができる。

【００１０】

【発明の実施の形態】以下図面について、本発明の一実施の形態を詳述する。

【００１１】（１）本実施の形態によるペットロボットの構成

図１において、１は全体として本実施の形態によるペットロボットを示し、胴体部ユニット２の前後左右にそれぞれ脚部ユニット３Ａ～３Ｄが連結されると共に、胴体部ユニット２の前端部及び後端部にそれぞれ頭部ユニット４及び尻尾部ユニット５が連結されることにより構成されている。

【００１２】この胴体部ユニット２の内部には冷却ファン（図示せず）が設けられ、当該冷却ファンを介して上面２Ａ及び下面２Ｂにはそれぞれ排気口２ＡＸ及び吸気口（図示せず）が形成されている。これによりペットロボット１では、冷却ファンの駆動に応じて、吸気口から吸入した空気を胴体部ユニット２の内部を介して排気口２ＡＸから外へ排出するようにして、当該胴体部ユニット２の内部温度を低減し得るようになされている。

【００１３】（２）ペットロボットシステムの内部構成

ここで図２に示すペットロボット１において、胴体部ユニット２には、このペットロボット１全体の動作を制御するコントローラ１０と、このペットロボット１の動力源となるバッテリ１１と、バッテリセンサ１２及び熱センサ１３からなる内部センサ部１４と、外部記憶メモリ１５及び内部記憶メモリ１６が接続された情報読書部１７と、加速度センサ１８及び角速度センサ１９とが収納されている。

【００１４】また頭部ユニット４には、「耳」に相当するマイクロホン２０と、「目」に相当するＣＣＤ（Charge Coupled Device）カメラ２１と、タッチセンサ２２

と、「口」に相当するスピーカ２３と、赤外線距離センサ等でなる距離センサ２４などがそれぞれ所定位置に配設されている。

【００１５】さらに各脚部ユニット３Ａ～３Ｄの関節部分や、各脚部ユニット３Ａ～３Ｄ及び胴体部ユニット２の各連結部分、頭部ユニット４及び胴体部ユニット２の連結部分、並びに尻尾部ユニット５及び胴体部ユニット２の連結部分などにはそれぞれアクチュエータ$3AA_1$～$3AA_x$、$3BA_1$～$3BA_x$、$3CA_1$～$3CA_x$、$3DA_1$～$3DA_x$、$4A_1$～$4A_L$、$5A_1$～$5A_M$が配設されている。そして頭部ユニット４のマイクロホン２０は、ユーザから図示しないサウンドコマンダ（操作内容に応じて異なる音階の音を発生するコマンダ）により音階として与えられる「歩け」、「伏せ」又は「ボールを追いかけろ」等の指令音を集音し、得られた音声信号Ｓ１をコントローラ１０に送出する。またＣＣＤカメラ２１は、前方向の状況を撮像し、得られた画像信号Ｓ２をコントローラ１０に送出すると共に、距離センサ２４は、前方の対象物までの距離を測定し、当該測定結果を距離測定信号Ｓ３としてコントローラ１０に送出する。

【００１６】さらにタッチセンサ２２は、図１において明らかなように頭部ユニット４の上部に設けられており、ユーザからの「なでる」や「たたく」といった物理的な働きかけにより受けた圧力を検出し、検出結果を圧力検出信号Ｓ４としてコントローラ１０に送出する。

【００１７】さらに胴体部ユニット２のバッテリセンサ１２は、バッテリ１１の残量を複数段階に分けて検出し、当該各段階の検出結果をバッテリ残量検出信号Ｓ５として順次コントローラ１０に送出する。

【００１８】さらに胴体部ユニット２の熱センサ１３は、ペットロボット１の内部温度を検出し、当該検出結果を熱検出信号Ｓ６としてコントローラ１０に送出する。

【００１９】さらに胴体部ユニット２の加速度センサ１８は、数十ミリ秒単位で３軸（Ｘ軸、Ｙ軸、Ｚ軸）方向の加速度をそれぞれ検出し、当該検出結果を加速度検出信号Ｓ７としてコントローラ１０に送出する。また角速度センサ１９は、数十ミリ秒単位で３各（Ｒ角、Ｐ角、Ｙ角）方向の回転角速度を検出し、当該検出結果を角速度検出信号Ｓ８としてコントローラ１０に送出する。

【００２０】コントローラ１０は、マイクロホン２０、ＣＣＤカメラ２１、距離センサ２４、タッチセンサ２２、バッテリセンサ１２、熱センサ１３、加速度センサ１８、角速度センサ１９から与えられる音声信号Ｓ１、画像信号Ｓ２、距離測定信号Ｓ３、圧力検出信号Ｓ４、バッテリ残量検出信号Ｓ５、熱検出信号Ｓ６、加速度検出信号Ｓ７及び角速度検出信号Ｓ８などに基づいて、周囲の状況や、ユーザからの指令、ユーザからの働きかけなどの有無を判断する。

【００２１】そしてコントローラ１０は、この判断結果と外部記憶メモリ１５から情報読書部１７を介して入力される制御プログラムとに基づいて続く行動を決定し、決定結果に基づいて必要なアクチュエータ$3AA_1$～$3AA_x$、$3BA_1$～$3BA_x$、$3CA_1$～$3CA_x$、$3DA_1$～$3DA_x$、$4A_1$～$4A_L$、$5A_1$～$5A_M$を駆動させることにより、頭部ユニット４を上下左右に振らせたり、尻尾部ユニット５を動かせたり、各脚部ユニット３Ａ～３Ｄを駆動して歩行させるなどの行動や動作を行わせる。なお以下においては、動作の集合を行動と定義して使用するものとする。

【００２２】またこの際コントローラ１０は、必要に応じて所定の音声信号Ｓ９をスピーカ２３に与えることにより当該音声信号Ｓ９に基づく音声を外部に出力させたり、このペットロボット１の「目」の位置に設けられた図示しないＬＥＤ（Light Emitting Diode）を点灯、消灯又は点滅させる。

【００２３】このようにしてこのペットロボット１においては、周囲の状況及び制御プログラム等に基づいて自律的に行動し得るようになされている。

【００２４】また胴体部ユニット２内の外部記憶メモリ１５は、外部から挿入可能なメモリスティック等の記録媒体でなり、当該記録媒体にはペットロボット１全体についての上述した制御プログラムが予め格納されている。さらに内部記憶メモリ１６には、ハードウェア情報、キャリブレーション情報、エラー動作実行プログラム、学習情報及び個人情報などが書換え可能な状態で格納されている。これら外部記憶メモリ１５及び内部記憶メモリ１６に格納されている各種のプログラム及び情報は、コントローラ１０の制御に応じて情報読書部１７が読み書きし得るようになされている。

【００２５】これによりコントローラ１０は、情報読書部１７によって外部記憶メモリ１５及び内部記憶メモリ１６から読み出された各種のプログラム及び情報に基づいて、ペットロボット１の行動を決定することにより、当該決定に対応して必要なアドレス$3AA_1$～$5A_M$を駆動し、必要に応じてスピーカ２３から音声を出力するようになされている。

【００２６】このようにしてこのペットロボット１においては、外部記憶メモリ１５及び内部記憶メモリ１６に格納されている各種のプログラム及び情報に従って、ペットロボット１の自律的な行動を個性的に変化させ得るようになされている。

【００２７】（３）制御プログラムのソフトウェア構成

ここでペットロボット１における上述の制御プログラムのソフトウェア構成を図３に示す。この図３からも明らかなように、制御プログラムは、意味変換オブジェクト３０、感情・本能生成オブジェクト３１、行動決定オブジェクト３２及び行動生成オブジェクト３３から構成されている。

【００２８】この場合、意味変換オブジェクト３０は、マイクロホン２０から与えられる音声信号Ｓ１、ＣＣＤカメラ２１から与えられる画像信号Ｓ２、距離センサ２４から与えられる距離測定信号Ｓ３、タッチセンサ２２から与えられる圧力検出信号Ｓ４、加速度センサ１８から与えられる加速度検出信号Ｓ７、及び角速度センサ１９から与えられる角速度検出信号Ｓ８に基づいて、ペットロボット１の周囲の状態や、ユーザからの指令、ユーザの働きかけなどの有無を認識すると共に、内部センサ１４を構成するバッテリセンサ１２及び熱センサ１３から与えられるバッテリ残量検出信号Ｓ５及び熱検出信号Ｓ６に基づいて、バッテリ１１の残量状態やペットロボット１の内部温度を認識した後、これらの認識結果を感情・本能生成オブジェクト３１及び行動決定オブジェクト３２に通知する。

【００２９】感情・本能生成オブジェクト３１は、意味変換オブジェクト３０から与えられる認識結果と、内部記憶メモリ１６に格納されている個人情報３４と、後述のように行動決定オブジェクト３２から与えられる実行した行動を表す通知とに基づいてペットロボット１の感情及び本能の状態を決定し、当該感情及び本能の状態が所定レベルを越えた場合には、これを行動決定オブジェクト３２に通知する。

【００３０】すなわち感情・本能生成オブジェクト３１は、「喜び」、「悲しみ」、「怒り」、「驚き」、「恐怖」及び「嫌悪」の各情動の強さをそれぞれ表す合計６つのパラメータを保持する感情モデルと、「愛情欲」、「探索欲」、「運動欲」及び「食欲」の各欲求の強さを＊それぞれ表す合計４つのパラメータを保持する本能モデルとを有している。

【００３１】また内部記憶メモリ１６には、個人情報３４として、例えば「叩かれた」ときには「怒り」のパラメータを上げると共に「喜び」のパラメータを下げ、「撫でられた」ときには「喜び」のパラメータを上げると共に「怒り」のパラメータを下げ、ある行動を発現したときには「運動欲」のパラメータを上げると共に「喜び」のパラメータを上げるといったような、意味変換オブジェクト３０の認識結果と、後述の行動生成オブジェクト３３からの行動を行ったという通知とに対してどの情動又は欲求のパラメータの値を増加又は減少させるかといったデータが格納されている。

【００３２】そして感情・本能生成オブジェクト３１は、意味変換オブジェクト３０から与えられる認識結果や、行動決定オブジェクト３２からの通知などに基づいて周期的に感情モデル又は本能モデルの対応する情動又は欲求のパラメータの値を個人情報に基づいて変更する。

【００３３】より具体的には、感情・本能生成オブジェクト３１は、各情動について、その情動の１周期前のパラメータ値を$E_{(n-1)}$、その周期中に与えられた認識結果及び行動決定オブジェクト３２からの通知内容に基づき所定の演算により得られる数値をＰ、その情動に対して予め設定された感度を表す係数値をｋｅとして、次式

【００３４】

【数１】

$$E_{(n)} = k_e * P + E_{(n-1)} \quad \cdots\cdots (1)$$

【００３５】によりその情動の次の周期のパラメータ値$E_{(n)}$を算出し、その情動のパラメータ値をこのパラメータ値$E_{(n)}$に変更する。

【００３６】また感情・本能生成オブジェクト３１は、各欲求について、その欲求の１周期前のパラメータ値を$I_{(n-1)}$、その周期中に与えられた認識結果及び行動決定オブジェクト３２からの通知内容に基づき所定の演算により得られる数値をＱ、その欲求に対して予め設定された感度を表す係数値をｋｉとして、次式

【００３７】

【数２】

$$I_{(n)} = k_i * Q + I_{(n-1)} \quad \cdots\cdots (2)$$

【００３８】によりその欲求の次の周期のパラメータ値$I_{(n)}$を算出し、その欲求のパラメータ値をこのパラメータ値$I_{(n)}$に変更する。

【００３９】そして感情・本能生成オブジェクト３１は、このような各パラメータ値の更新処理の結果としていずれかの情動又は欲求のパラメータのパラメータ値がその情動又は本能に対して予め設定された値を越えたときに、これを行動決定オブジェクト３２に通知する。

【００４０】行動決定オブジェクト３２は、意味変換オブジェクト３０から与えられる認識結果と、感情・本能生成オブジェクト３１からの通知と、内部記憶メモリ１６に格納されている行動モデル３５及び歩行決定情報３６とに基づいて続く行動を決定し、決定結果を行動生成オブジェクト２３に通知する。

【００４１】なおこの実施の形態の場合、行動決定オブジェクト３２は、次の行動を決定する手法として、図４に示すような１つのノード（状態）ＮＯＤＥ。～ＮＯＤＥ$_n$から他のどのノードＮＯＤＥ。～ＮＯＤＥ$_n$に遷移するかを各ノードＮＯＤＥ。～ＮＯＤＥ$_n$間を接続するアークＡＲＣ$_1$～ＡＲＣ$_{n^2}$に対してそれぞれ設定された遷移確率Ｐ$_1$～Ｐ$_{n^2}$に基づいて確率的に決定する確率オートマトンと呼ばれるアルゴリズムを用いる。

【００４２】より具体的には、内部記憶メモリ１６には行動モデル３５として各ノードＮＯＤＥ。～ＮＯＤＥ$_n$ごとの図５に示すような状態遷移表３７が格納されており、行動決定オブジェクト３２がこれら状態遷移表３７に基づいて続く行動を設定するようになされている。

【００４３】すなわち状態遷移表３７においては、その

ノードＮＯＤＥ。～ＮＯＤＥｎにおいて遷移条件とする入力イベント（認識結果）が「入力イベント」の行に優先順に列記され、その遷移条件についてのさらなる条件が「データ名」及び「データ範囲」の行における対応する列に記述されている。

【００４４】従って図５の状態遷移表で表されるノードＮＯＤＥ100 では、「ボールを検出（ＢＡＬＬ）」という認識結果が与えられた場合に、当該認識結果と共に与えられるそのボールの「大きさ（ＳＩＺＥ）」が「０から1000の範囲（０，1000）」であることや、「障害物を検出（ＯＢＳＴＡＣＬＥ）」という認識結果が与えられた場合に、当該認識結果と共に与えられるその障害物までの「距離（ＤＩＳＴＡＮＣＥ）」が「０～100 の範囲（０，100 ）」であることが他のノードに遷移するための条件となっている。

【００４５】またこのノードＮＯＤＥ100 では、認識結果の入力がない場合においても、行動決定オブジェクトが周期的に参照する感情・本能生成オブジェクト内の感情モデル及び本能モデルの各情動及び各欲求のパラメータ値のうち、「喜び（ＪＯＹ）」、「驚き（ＳＵＰＲＩＳＥ）」若しくは「悲しみ（ＳＡＤＮＥＳＳ）」のいずれかのパラメータ値が「50～100 の範囲（50，100 ）」であるときには他のノードに遷移することができるようになっている。

【００４６】また状態遷移表３７においては、「他のノードへの遷移確率」の欄における「遷移先ノード」の列にそのノードＮＯＤＥ。～ＮＯＤＥｎから遷移できるノード名が列記されると共に、「入力イベント名」、「データ値」及び「データの範囲」の各行に記述された全ての条件が揃ったときに遷移できる他の各ノードＮＯＤＥ。～ＮＯＤＥｎへの遷移確率が「他のノードへの遷移確率」の欄における「出力行動」の行に記述されている。なお「他のノードへの遷移確率」の欄における各行の遷移確率の和は100〔％〕となっている。

【００４７】従って図５の状態遷移表３７で表されるノードＮＯＤＥ100 では、例えば「ボールを検出（ＢＡＬＬ）」し、そのボールの「大きさ（ＳＩＺＥ）」が「０～1000の範囲（０，1000）」であるという認識結果が与えられた場合には、「30〔％〕」の遷移確率で「ノードＮＯＤＥ120 （node 120）」に遷移でき、そのとき「ＡＣＴＩＯＮ　１」の行動が出力されることとなる。

【００４８】そして行動モデル３５は、このような状態遷移表３７として記述されたノードＮＯＤＥ。～ＮＯＤＥｎがいくつも繋がるようにして構成されている。そして行動決定オブジェクト３２は、意味変換オブジェクト３０から認識結果が与えられたときや、感情・本能生成オブジェクト３１から通知が与えられたときなどに、内部記憶メモリ１６に格納されている対応するノードＮＯＤＥ。～ＮＯＤＥｎの状態遷移表３７を利用して次の行動や動作を確率的に決定する。

【００４９】かかる構成に加えて内部記憶メモリ１６には、歩行決定情報３６として感情・本能生成オブジェクト３１における感情モデルの各情動ごとに図６に示すような対応テーブル３８がファイル化されて格納されており、行動決定オブジェクト３２がこれら対応テーブル３８に基づいてペットロボット１の歩行パターンを情動及びその度合いに応じて決定するようになされている。

【００５０】すなわち各情動ごとの対応テーブル３８においては、各情動ごとに歩行パターンの表現が異なると共に、当該各情動のパラメータ値に応じて５段階に表現の度合いがレベル分けされている。

【００５１】まず「喜び」を表す情動のパラメータ値が０～20の範囲ではレベルＪ１、21～40の範囲ではレベルＪ２、41～60の範囲ではレベルＪ３、61～80の範囲ではレベルＪ４、81～100 の範囲ではレベルＪ５に応じた歩行パターンがそれぞれ設定されている。この場合「喜び」を表す情動における歩行パターンは、レベルＪ１からレベルＪ５まで順次段階的に、足をより高く上げると共に歩行スピードが速くなるように設定されている。

【００５２】また「悲しみ」を表す情動のパラメータ値が０～20の範囲ではレベルＳａ１、21～40の範囲ではレベルＳａ２、41～60の範囲ではレベルＳａ３、61～80の範囲ではレベルＳａ４、81～100 の範囲ではレベルＳａ５に応じた歩行パターンがそれぞれ設定されている。この場合「悲しみ」を表す情動における歩行パターンは、レベルＳａ１からレベルＳａ５まで順次段階的に、頭部を低く垂れると共に歩行スピードが遅くなるように設定されている。

【００５３】さらに「怒り」を表す情動のパラメータ値が０～20の範囲ではレベルＡ１、21～40の範囲ではレベルＡ２、41～60の範囲ではレベルＡ３、61～80の範囲ではレベルＡ４、81～100 の範囲ではレベルＡ５に応じた歩行パターンがそれぞれ設定されている。この場合「怒り」を表す情動に応じた歩行パターンは、レベルＡ１からレベルＡ５まで順次段階的に、足を高く上げて速く下ろす（地団駄を踏む）と共に体を激しく揺らすように設定されている。

【００５４】さらに「驚き」を表す情動のパラメータ値が０～20の範囲ではレベルＳｕ１、21～40の範囲ではレベルＳｕ２、41～60の範囲ではレベルＳｕ３、61～80の範囲ではレベルＳｕ４、81～100 の範囲ではレベルＳｕ５に応じた歩行パターンがそれぞれ設定されている。この場合「驚き」を表す情動に応じた歩行パターンは、レベルＳｕ１からレベルＳｕ５まで順次段階的に、足を高く速く上げる（飛び跳ねる）ように設定されている。

【００５５】さらに「嫌悪」を表す情動のパラメータ値が０～20の範囲ではレベルＨ１、21～40の範囲ではレベルＨ２、41～60の範囲ではレベルＨ３、61～80の範囲ではレベルＨ４、81～100 の範囲ではレベルＨ５に応じた歩行パターンがそれぞれ設定されている。この場合「嫌

悪」を表す情動に応じた歩行パターンは、レベルＨ１からレベルＨ５まで順次段階的に、頭を速く左右に振りながら遅く歩くように設定されている。

【００５６】従って行動決定オブジェクト３２は、周期的に感情・本能生成オブジェクト３１内の感情モデルの各情動のパラメータ値を参照しながら、ペットロボット１の歩行パターンをその情動の種類及び当該情動の度合いに応じて選択的に決定した後、当該決定した歩行パターンを、上述したノードＮＯＤＥ0 ～ＮＯＤＥn の状態遷移表３７を利用して確率的に決定した行動や動作に反映させた後、これらの決定結果を行動生成モジュール３３に通知するようになされている。

【００５７】行動生成モジュール３３は、行動決定モジュール３２からの通知に基づいて、ペットロボット１が指定された行動や動作を、情動及びその度合いに応じた歩行パターンを反映させながら発現するように、必要に応じて対応するアクチュエータ３ＡＡ1 ～５ＡＭ を駆動制御したり、対応する音声信号Ｓ９（図２）を生成してスピーカ２３に送出したり、又は「目」の位置のＬＥＤを点滅させる。

【００５８】このようにしてペットロボット１においては、外部記憶メモリ１５に格納された制御プログラム及び内部記憶メモリ１６に格納された各種制御用のデータに基づいて、自己及び周囲の状況や、ユーザからの指示及び働きかけに応じた自律的な行動を行うことができるようになされている。

【００５９】（４）具体的な行動発現例

（４－１）うろうろしているときにボールを見つけて喜び、近づいて蹴る場合ペットロボット１が一定時間放置された状態にあると次第に探索欲や運動欲が上昇することにより通常の歩行パターンを開始する。このときペットロボット１のＣＣＤカメラ２１の視界内にピンク色のボールを置くと、意味変換オブジェクト３０は、「ボール」という認識結果を得て、感情・本能生成オブジェクト３１において「喜び」のパラメータ値を上昇させる。

【００６０】行動決定オブジェクト３２は、喜びのパラメータ値が上昇したため、歩行パターンを通常のレベルＪ１から少し活発な歩行パターンであるレベルＪ２に変更してボールに近づく。やがてボールに近づくにつれ、ペットロボット１の内部には「ボール」という認識結果が何度も送られてくるため、喜びのパラメータ値が上昇し続け、歩行パターンもより活発なレベルＪ３さらにはレベルＪ４へと変更しながら歩行する。

【００６１】そして最終的にボールに接近して、当該ボールに蹴ることに成功したときには、喜びのパラメータ値はより一層上昇する。喜びがその動作グループにおいて指定された閾値を越えた場合に、その閾値に対応する喜びモーションを行うことで、喜びという内部状態をその変化の過程も含めて表現することができる。

【００６２】（４－２）ボールを取られて怒る場合

ペットロボット１はボールと遊んでいる間には喜びのパラメータ値が高くなっている。しかし、ボールが自ら蹴ったとき以外にＣＣＤカメラ２１の視界内から突然無くなった場合には、喜びのパラメータ値が下降する一方、驚きのパラメータ値が上昇する。このときペットロボット１は驚きの動作を行った後、ボールを探す動作を行うが、一定時間以上ボールが視界内に見当たらない場合には、次第に怒りのパラメータ値が上昇する。

【００６３】行動決定オブジェクト３２は、怒りのパラメータ値が上昇したため、歩行パターンを通常のレベルＡ１から順次レベルＡ２、Ａ３、Ａ４へと変更しながら地団駄を踏むと共に体を激しく揺らし続ける。それでもボールが見当たらずに、怒りのパラメータ値が上昇してレベルＡ５に至った場合には、その場で怒りのダンスを実行する。

【００６４】このように怒りの動作を行うことによって怒りの動作を一旦停止し、時間的に減少していく。減少する際にも歩行パターンをレベルＡ３、Ａ２、Ａ１と順次変更する。その途中で他の情動のパラメータ値が上昇した場合には、その情動のパラメータ値に従った歩行パターンをその情動の度合いに応じて選択する。

【００６５】（５）本実施の形態による動作及び効果

以上の構成において、このペットロボット１では、周囲の状況やユーザからの働きかけに基づいて、現在の状態から次の行動を選択して発現する。このとき現在の状態から次の行動へ遷移する際に、ペットロボット１の感情を表す情動の変化が比較的緩やかな場合（例えばボールに近づく場合やボールを探す場合など）には、その情動の種類及びその度合いに応じた歩行パターンを逐次選択して、かかる情動の変化の過程を当該選択した各歩行パターンによって表現させる。

【００６６】従ってこのペットロボット１では、特定の事象において感情の変化に応じて歩行パターンを変化させることができる。

【００６７】以上の構成によれば、このペットロボット１では、特定の事象において感情の変化に応じて歩行パターンを変化させるようにしたことにより、より一層の親近感や満足感をユーザに与えて、アミューズメント性を格段と向上させ得るペットロボットを実現できる。

【００６８】（６）他の実施の形態

なお上述の実施の形態においては、図１のように構成された４足歩行型のペットロボット１に適用するようにした場合について述べたが、本発明はこれに限らず、この他種々の構成の歩行型のロボットに広く適用することができる。

【００６９】この場合において上述の実施の形態では、複数の脚部３Ａ～３Ｄを駆動する駆動手段として、コントローラ１０及び各アクチュエータ３ＡＡ1 ～５Ｍ 等を適用するようにした場合について述べたが、駆動手段としては本発明を適用するロボット装置の形態に応じてこ

の他種々の構成を適用することができる。

【００７０】また上述の実施の形態においては、感情モデルに応じた情動の度合いに応じて歩行のパターンを変化させるように駆動手段を制御する制御手段を、コントローラ１０から構成するようにした場合について述べたが、本発明はこれに限らず、制御手段としては本発明を適用するロボット装置の形態に応じてこの他種々の構成を適用することができる。

【００７１】さらに上述の実施の形態においては、ペットロボット１の歩行パターンを各情動ごとにその度合いに応じた５段階のレベルでそれぞれ対応テーブル３８を用いて設定するようにした場合について述べたが、本発明はこれに限らず、情動の種類及びその度合いに応じて複数段階（２～４段階又は６段階以上）のレベルを設定するようにしても良い。

【００７２】この場合上述の実施の形態では、歩行パターンとして各脚部ユニット３Ａ～３Ｄの動きをパターン化するようにしたが、当該各脚部ユニット３Ａ～３Ｄの動きに加えて頭部ユニット４や尻尾部ユニット５の動きをもパターン化して情動の度合いに応じて段階的に変化させるようにしても良い。

【００７３】さらに上述の実施の形態においては、ペッ＊

$$\theta_{(n)} = E_{(n)} * k_r + \theta_0$$

【００７７】によりその情動に応じた各脚部ユニット３Ａ～３Ｄの関節角度$\theta_{(n)}$を算出し、その情動に応じた関節角度$\theta_{(n)}$で各脚部ユニット３Ａ～３Ｄを動作させる。

【００７８】具体的に、ペットロボット１がうろうろとしているときにピンク色のボールを見つけて喜び、近づいて蹴る場合、まずペットロボット１がＣＣＤカメラ２１の視界内にボールを見つけると、意味変換オブジェクト３０は「ボール」という認識結果を得て、感情・本能生成オブジェクト３１において「喜び」のパラメータ値を上昇させる。

【００７９】行動決定オブジェクト３２は、喜びのパラメータ値が上昇したため、両方の前脚部ユニット３Ａ、３Ｂの各第２関節を10〔°〕大きく動かすというパラメータ値に変更することにより、両方の前脚部ユニット３Ａ、３Ｂを少し高く上げる歩行に変更してより活発な歩き方でボールに近づく。

【００８０】やがてボールに近づくにつれ、ペットロボット１の内部にはボールという認識結果が何度も送られてくるため、喜びのパラメータ値が上昇し続け、両方の後脚部ユニット３Ｃ、３Ｄの各第１関節を10〔°〕大きく動かすパラメータ値に変更することにより、両方の前脚部ユニット３Ａ、３Ｂのみならず両方の後脚部ユニット３Ｃ、３Ｄをもより大きく動かす歩行となって一層活発な歩行をする。

【００８１】そして最終的にボールに接近して、当該ボールに蹴ることに成功したときには、喜びのパラメータ

＊トロボット１の歩行パターンを、内部記憶メモリ１６にファイル化された対応テーブル３８を格納しておき、情動の種類及びその度合いに対応する歩行パターンを当該対応テーブル３８から選択するようにした場合について述べたが、本発明はこれに限らず、要は情動の変化に応じて歩行パターンを変化させることができれば、この他にも角度パラメータ、速度パラメータ及び加速度パラメータ等を情動の変化に応じて変更させるようにして歩行パターンを変化させるようにしても良い。

【００７４】例えば角度パラメータを変更させる方法として、行動決定オブジェクト３２は、感情モデルに応じた各情動ごとにペットロボット１の各脚部ユニット３Ａ～３Ｄの関節角度及び回転角度をそれぞれ変更するようなパラメータを有している。

【００７５】実際に行動決定オブジェクト３２は、各情動について、その情動の所定周期のパラメータ値$E_{(n)}$、その情動に対して予め設定された感度を表す係数値をk_r、通常の歩行時に回転する関節の最小角度θ_0　として、次式

【００７６】

【数３】

$$\cdots\cdots (3)$$

値はより一層上昇する。喜びがその動作グループにおいて指定された閾値を越えた場合に、その閾値に対応する喜びモーションを行うことで、喜びという内部状態をその変化の過程も含めて表現することができる。

【００８２】

【発明の効果】上述のように本発明によれば、複数の脚部を有し、各脚部を所定パターンで駆動するようにして歩行するロボット装置において、各脚部を駆動する駆動手段と、感情モデルに応じた情動の度合いに応じて歩行のパターンを変化させるように駆動手段を制御する制御手段と設けるようにしたことにより、特定の事象において感情の変化に応じて歩行パターンを変化させることができ、かくしてアミューズメント性を格段と向上させ得るロボット装置を実現できる。

【００８３】また本発明によれば、複数の脚部を有し、各脚部を所定パターンで駆動するようにして歩行するロボット装置の制御方法において、感情モデルに応じた情動の度合いに応じて歩行のパターンを変化させるように各脚部を駆動するようにしたことにより、特定の事象において感情の変化に応じて歩行パターンを変化させることができ、かくしてアミューズメント性を格段と向上させ得るロボット装置の制御方法を実現できる。

【００８４】。

【図面の簡単な説明】

【図１】本実施の形態によるペットロボットの外観構成を示す斜視図である。

【図２】本実施の形態によるペットロボットの回路構成

13

を示すブロック図である。

【図３】ペットロボットのソフトウェア構成を示すブロック図である。

【図４】確率オートマトンを示す概念図である。

【図５】状態遷移表を示す概念図である。

【図６】歩行パラメータを表す対応テーブルを示す概念図である。

【符号の説明】

１……ペットロボット、２……胴体部ユニット、３Ａ～３Ｄ……脚部ユニット、３ＡＡ$_1$～５Ａ$_n$……アクチュエータ、４……頭部ユニット、５……尻尾部ユニット、１０……コントローラ、１２……バッテリセンサ、１３……熱センサ、１５……外部記憶メモリ、１６……内部記憶メモリ、２０……マイクロホン、２１……ＣＣＤカメラ、２２……タッチセンサ、２３……スピーカ、２４……距離センサ、３０……意味変換オブジェクト、３１……感情・本能生成オブジェクト、３２……行動決定オブジェクト、３３……行動生成オブジェクト、３４……個人情報、３５……行動モデル、３６……歩行決定情報、３７……状態遷移表、３８……対応テーブル。

14

【図１】

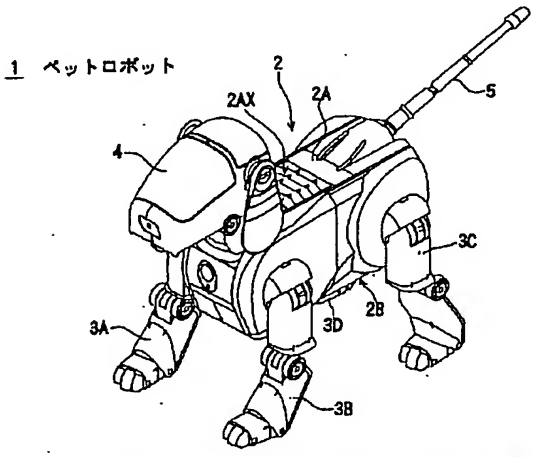

図１　本実施の形態によるペットロボットの構成

【図３】

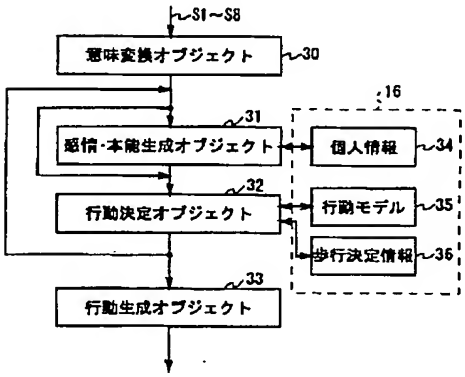

図３　ペットロボットの行動生成

【図２】

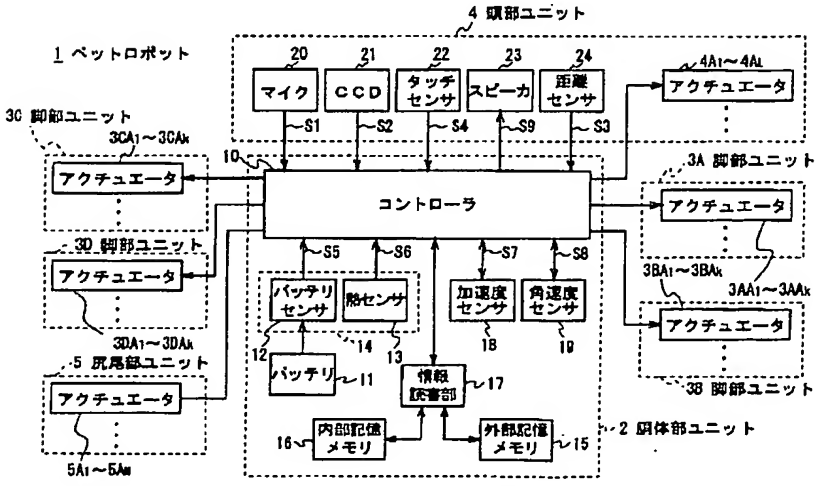

図２　ペットロボットの内部構成

【図４】

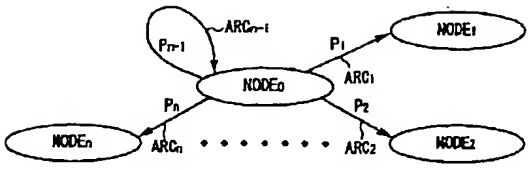

図４　確率オートマトン

【図５】

NODE100　　NODE120

node 100	入力イベント名	データ名	データの範囲	他のノードへの遷移確率 Di					
遷移先ノード				node 120	node120	node 1000			node 600
出力行動				ACTION 1	ACTION 2	MOVE BACK			ACTION 4
1	BALL	SIZE	0.1000	30%					
2	PAT				40%				
3	HIT				20%				
4	MOTION					50%			
5	OBSTACLE	DISTANCE	0.100			100%			
6		JOY	50.100						
7		SUPRISE	50.100						
8		SADNESS	50.100						

37

図５　状態遷移表

【図６】

パラメータ値 / 情動の種類	0～20	21～40	41～60	61～80	81～100
喜び	J1	J2	J3	J4	J5
悲しみ	Sa1	Sa2	Sa3	Sa4	Sa5
怒り	A1	A2	A3	A4	A5
驚き	Su1	Su2	Su3	Su4	Su5
恐怖	F1	F2	F3	F4	F5
嫌悪	H1	H2	H3	H4	H5

38

図６　各情動ごとの歩行パターンを表す対応テーブル

フロントページの続き

Ｆターム(参考) 3F059 AA00 BB06 CA05 DB04 DC01
DC04 DC08 DD18 FA03 FB12
3F060 AA00 CA14 GA05 GA13 GB21
GD13 GD14 GD15
5H004 GA26 GB16 HA07 HB01 HB03
HB07 HB09 HB15 JA02 JA03
JA05 JB05 JB06 JB07 KD62
LA18 MA23 MA29 MA33
9A001 HH19 KK62

CLAIMS

[Claim(s)]
[Claim 1]A robot device which has two or more legs, and walks it with a prescribed pattern as drives each above-mentioned leg, comprising:
A driving means which drives each above-mentioned leg.
A control means which controls the above-mentioned driving means to change a pattern of the above-mentioned walk according to a degree of an emotion according to a feeling model.

[Claim 2]The robot device according to claim 1, wherein a pattern of the above-mentioned walk changes gradually according to a degree of the above-mentioned emotion.
[Claim 3]A control method of a robot device driving each above-mentioned leg in a control method of a robot device of having two or more legs, and walking it with a prescribed pattern as each above-mentioned leg is driven so that a pattern of the above-mentioned walk may be changed according to a degree of an emotion according to a feeling model.
[Claim 4]A control method of the robot device according to claim 3, wherein a pattern of the above-mentioned walk changes gradually according to a degree of the above-mentioned emotion.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention is applied to a pet robot, concerning a robot device and a method for controlling the same, and is preferred.
[0002]
[Description of the Prior Art]In recent years, the quadrapedalism type pet robot which performs operation regular according to the environment of the instructions from a user or the circumference is proposed and developed by this application applicant for a patent. This pet robot has the shape similar to the dog bred in an ordinary home, or a cat, and operates according to the instructions from a user, the surrounding environment, etc.
[0003]
[Problem(s) to be Solved by the Invention]By the way, when it has a function which expresses various feeling according to the influence from a surrounding situation and user in this pet robot, expressing a rapid change of feeling comparatively for a short time is performed, but. If change of the loose feeling that time is needed further comparatively can be expressed based on the process, the much more sense of closeness and satisfaction will be given to a user, and it will be thought that the amusement nature as a pet robot can be raised more.
[0004]If a loose change of such feeling can be especially expressed using the gait pattern of a pet robot, it will be easy to recognize the process in which the emotional expression of a pet robot changes for a user, and it will be thought that diversity can be given to those expressions.
[0005]This invention was made in consideration of the above point, and tends to propose a robot device which may raise amusement nature markedly, and a method for controlling the same.
[0006]
[Means for Solving the Problem]In [in order to solve this technical problem] this invention, It has two or more legs and was made to provide in a robot device which walks it with a prescribed pattern as drives each leg with a driving means which drives each leg, and a control means which controls a driving means to change a pattern of a walk according to a degree of an emotion according to a feeling model.
[0007]As a result with this pet robot, a gait pattern can be changed according to change of feeling in a specific phenomenon.
[0008]It has two or more legs and was made to drive each leg in this invention, in a control method of a robot device of walking it with a prescribed pattern as each leg is driven, so that a pattern of a walk may be changed according to a degree of an emotion according to a feeling model.
[0009]As a result with this pet robot, a gait pattern can be changed according to change of feeling in a specific phenomenon.
[0010]
[Embodiment of the Invention]About a drawing, the 1 embodiment of this invention is explained in full detail below.
[0011](1) In the lineblock diagram 1 of the pet robot by this embodiment, the pet robot

by this embodiment is shown as a whole, and the leg unit 3A - 3D are connected with front and rear, right and left of the idiosoma unit 2, respectively, and 1. It is constituted by connecting the head unit 4 and the tail part unit 5 with the front end part and rear end part of the idiosoma unit 2, respectively.

[0012]A cooling fan (not shown) is formed in the inside of this idiosoma unit 2, and exhaust-port 2AX and an inlet port (not shown) are formed in the upper surface 2A and undersurface 2B via the cooling fan concerned, respectively. Thereby, with the pet robot 1, according to the drive of a cooling fan, as the air inhaled from the inlet port is discharged outside from exhaust-port 2AX via the inside of the idiosoma unit 2, it is made as [reduce / the internal temperature of the idiosoma unit 2 concerned].

[0013](2) the internal configuration of a pet robot system -- to the idiosoma unit 2 in the pet robot 1 shown in drawing 2 here. The controller 10 which controls operation of this pet robot 1 whole, and the battery 11 used as the source of power of this pet robot 1, The internal sensor part 14 which consists of the battery sensor 12 and the heat sensor 13, the information reading part 17 to which the enternal memory memory 15 and the internal memory memory 16 were connected, and the acceleration sensor 18 and the angular velocity sensor 19 are stored.

[0014]The microphone 20 which is equivalent to an "ear" at the head unit 4 and the CCD (Charge Coupled Device) camera 21 equivalent to "eyes", The touch sensor 22, the loudspeaker 23 equivalent to a "mouth", the distance sensors 24 that become by an infrared distance sensor etc., etc. are allocated in the prescribed position, respectively.

[0015]Furthermore, the joint portion of each leg unit 3A - 3D, and each joining segment of each leg unit 3A - 3D, and the idiosoma unit 2, To the joining segment of the joining segment of the head unit 4 and the idiosoma unit 2, the tail part unit 5, and the idiosoma unit 2, respectively Actuator $3AA_1$ - $3AA_K$, $3BA_1$ - $3BA_K$, $3CA_1$ - $3CA_K$, $3DA_1$ - $3DA_K$, $4A_1$ - $4A_L$, $5A_1$ - $5A_M$ are allocated. And the microphone 20 of the head unit 4, The audio signal S1 acquired by collecting the instruction sound given as a scale by the sound commander (commander who generates the sound of a different scale according to the contents of operation) who does not illustrate from a user, such as "walk", "lie down", or "pursue a ball", is sent out to the controller 10. CCD camera 21 sends out the picture signal S2 acquired by picturizing the situation of front to the controller 10, and the distance sensors 24 measure the distance to a front subject, and it sends them out to the controller 10 by making the measurement result concerned into the range measurement signal S3.

[0016]Furthermore, in drawing 1, the touch sensor 22 is formed in the upper part of the head unit 4 so that clearly, it detects the pressure were pressured by "it strokes" and the physical influence of "striking" from a user, and sends it out to the controller 10 by making a detection result into pressure detection signal S4.

[0017]Furthermore, the battery sensor 12 of the idiosoma unit 2 divides the residue of the battery 11 into two or more steps, detects it, and sends it out to the controller 10 one by one by making the detection result of each stage concerned into the battery residual quantity detecting signal S5.

[0018]Furthermore, the heat sensor 13 of the idiosoma unit 2 detects the internal temperature of the pet robot 1, and sends it out to the controller 10 by making the detection result concerned into the heat detecting signal S6.

[0019]Furthermore, the acceleration sensor 18 of the idiosoma unit 2 detects the

acceleration of the direction of 3 axes (the X-axis, a Y-axis, Z-axis) per tens of milliseconds, respectively, and sends it out to the controller 10 by making the detection result concerned into the acceleration detecting signal S7. The angular velocity sensor 19 detects the angular rate of rotation of 3 each (R angle, P angle, Y angle) direction per tens of milliseconds, and sends it out to the controller 10 by making the detection result concerned into the angular velocity detecting signal S8.

[0020]The controller 10, The audio signal S1 and the picture signal S2 which are given from the microphone 20, CCD camera 21, the distance sensors 24, the touch sensor 22, the battery sensor 12, the heat sensor 13, the acceleration sensor 18, and the angular velocity sensor 19, the range measurement signal S3, pressure detection signal S4, the battery residual quantity detecting signal S5, Based on the heat detecting signal S6, the acceleration detecting signal S7, the angular velocity detecting signal S8, etc., existence, such as the surrounding situation, instructions from a user, influence from a user, is judged.

[0021]And the controller 10 opts for the action which continues based on the control program inputted via the information reading part 17 from this decision result and the enternal memory memory 15, Based on decision results, required actuator $3AA_1$ - $3AA_K$, By making $3BA_1$ - $3BA_K$, $3CA_1$ - $3CA_K$, $3DA_1$ - $3DA_K$, $4A_1$ - $4A_L$, $5A_1$ - $5A_M$ drive, Action and operation of the head unit 4 being made to be able to shake vertically and horizontally, being able to move the tail part unit 5, or driving and walking him around each leg unit 3A - 3D are made to perform. A set of operation shall be used for below, defining it as action.

[0022]In this case, the controller 10 makes the sound based on the audio signal S9 concerned output outside by giving predetermined audio signal S9 to the loudspeaker 23 if needed, or. LED (Light Emitting Diode) which was provided in the position of the "eye" of this pet robot 1 and which is not illustrated is turned on, switched off or blinked.

[0023]Thus, in this pet robot 1, it is made as [act / based on a surrounding situation, a control program etc. / it / autonomously].

[0024]The enternal memory memory 15 in the idiosoma unit 2 becomes with recording media, such as a memory stick which can be inserted from the exterior, and the control program mentioned above about the pet robot 1 whole is beforehand stored in the recording medium concerned. Furthermore, it is stored in the internal memory memory 16 in the state where hardware information, calibration information, an error operation execution program, learning information, personal information, etc. are rewritable. Various kinds of programs and information which are stored in these enternal memory memory 15 and the internal memory memory 16 are made as [write / according to control of the controller 10 / reading and the information reading part 17].

[0025]By this the controller 10 by opting for action of the pet robot 1 based on various kinds of programs and information which were read from the enternal memory memory 15 and the internal memory memory 16 by the information reading part 17, Corresponding to the determination concerned, required address $3AA_1$ - $5A_M$ are driven, and it is made as [output / if needed / from the loudspeaker 23 / a sound].

[0026]Thus, in this pet robot 1, it is made as [change / autonomous action of the pet robot 1 / with personality] according to various kinds of programs and information which are stored in the enternal memory memory 15 and the internal memory memory 16.

[0027](3) the software configuration of a control program -- here shows the software

configuration of the above-mentioned control program in the pet robot 1 to drawing 3. The control program comprises the semantic conversion object 30, feeling and an instinct generation object 31, the action determination object 32, and the action generation object 33 so that clearly also from this drawing 3.

[0028]In this case, the semantic conversion object 30, The audio signal S1 given from the microphone 20, the picture signal S2 given from CCD camera 21, the range measurement signal S3 given from the distance sensors 24, pressure detection signal S4 given from the touch sensor 22, the acceleration detecting signal S7 given from the acceleration sensor 18, And based on the angular velocity detecting signal S8 given from the angular velocity sensor 19, recognize existence, such as a state around the pet robot 1, instructions from a user, a user's influence, and. Based on the battery residual quantity detecting signal S5 and the heat detecting signal S6 which are given from the battery sensor 12 and the heat sensor 13 which constitute the internal sensor 14, After recognizing the residue state of the battery 11, and the internal temperature of the pet robot 1, these recognition results are notified to feeling, the instinct generation object 31, and the action determination object 32.

[0029]The recognition result to which feeling and the instinct generation object 31 are given from the semantic conversion object 30, Based on the personal information 34 stored in the internal memory memory 16, and the notice showing the performed action which is given from the action determination object 32 like the after-mentioned, the feeling of the pet robot 1 and the state of instinct are determined, When the state of the feeling concerned and instinct exceeds a predetermined level, this is notified to the action determination object 32.

[0030]That is, feeling and the instinct generation object 31 are provided with the following.

The feeling model holding a total of six parameters with which the strength of each emotion of "joy", "sadness", "anger", "surprise", "fear", and "dislike" is expressed, respectively.

The instinct model holding a total of four parameters with which the strength of each desire of "love avarice", "search avarice", "movement avarice", and "appetite" is expressed, respectively.

[0031]As the personal information 34, when "being struck" by the internal memory memory 16, for example, raise the parameter of "anger" to it, and the parameter of "joy" is lowered to it, When "stroked", raise the parameter of "joy", and the parameter of "anger" is lowered, When a certain action is revealed, raise the parameter of "movement avarice", and the parameter of "joy" The recognition result of ********** and the semantic conversion object 30, The data the value of which emotion or the parameter of desire to increase or decrease to the notice of having performed action from the below-mentioned action generation object 33 is stored.

[0032]And feeling and the instinct generation object 31 change the value of the emotion or the parameter of desire with which a feeling model or an instinct model corresponds periodically based on the recognition result given from the semantic conversion object 30, the notice from the action determination object 32, etc. based on personal information.

[0033]More specifically feeling and the instinct generation object 31, The coefficient

value showing the sensitivity beforehand set up to P and its emotion in the numerical value acquired by a predetermined operation about each emotion based on the notice content from a recognition result and the action determination object 32 to which the parameter value in front of 1 cycle of the emotion was given into $E_{(n-1)}$ and its cycle is set to ke, and it is a following formula. [0034]

[Equation 1]

$$E_{(n)} = k_e * P + E_{(n-1)} \quad \cdots\cdots (1)$$

[0035]It is alike, parameter value $E_{(n)}$ of the next cycle of that emotion is computed more, and the parameter value of that emotion is changed into this parameter value $E_{(n)}$.

[0036]Feeling and the instinct generation object 31 the parameter value in front of 1 cycle of the desire about each desire $I_{(n-1)}$, The coefficient value showing the sensitivity beforehand set up to Q and its desire in the numerical value acquired by a predetermined operation based on the notice content from a recognition result and the action determination object 32 given into the cycle is set to ki, and it is a following formula. [0037]

[Equation 2]

$$I_{(n)} = k_i * Q + I_{(n-1)} \quad \cdots\cdots (2)$$

[0038]It is alike, parameter value $I_{(n)}$ of the next cycle of that desire is computed more, and the parameter value of that desire is changed into this parameter value $I_{(n)}$.

[0039]And feeling and the instinct generation object 31 notify this to the action determination object 32, when the parameter value of one of emotions or the parameter of desire exceeds the value beforehand set up to the emotion or instinct as a result of the update process of such each parameter value.

[0040]The recognition result to which the action determination object 32 is given from the semantic conversion object 30, It opts for the action which continues based on the notice from feeling and the instinct generation object 31, and the behavior model 35 and the walk decision information 36 which are stored in the internal memory memory 16, and decision results are notified to the action generation object 23.

[0041]In the case of this embodiment, the action determination object 32, As the technique of opting for the next action, One node as shown in drawing 4. (State) As opposed to arc ARC_1 which connects between each node $NODE_0$ - $NODE_n$ for to other node $NODE_0$ of which - $NODE_n$ it changes from $NODE_0$ - $NODE_n$ - ARC_{n+1}. The algorithm called the probabilistic automaton determined probable based on transition probability P_1 set up, respectively - P_{n+1} is used.

[0042]The state transition table 37 as shown in drawing 5 for every node $NODE_0$ - $NODE_n$ as the behavior model 35 is more specifically stored in the internal memory memory 16, It is made as [set / the action determination object 32 / action which continues based on these state transition tables 37].

[0043]Namely, in the state transition table 37, an input event (recognition result) made into transition conditions in the node $NODE_0$ - $NODE_n$ is listed by line of an "input event" at a priority, Further conditions about the transition condition are described by a "data name" and corresponding sequence in a line of a "data range."

[0044]Therefore, in node NODE100 expressed in a state transition table of drawing 5. When a recognition result of "detecting a ball (BALL)" is given, "A range (0, 1000)" of

"a size (SIZE)" of the ball given with the recognition result concerned is 0 to 1000, When a recognition result of "detecting an obstacle (OBSTACLE)" is given, they have been conditions for that "ranges (0,100)" of "distance (DISTANCE)" to the obstacle done with the recognition result concerned is 0-100 to change to other nodes.

[0045]Also in a case where there is no input of a recognition result this node NODE100, Inside of each emotion of a feeling model in feeling and an instinct generation object which an action determination object refers to periodically, and an instinct model, and parameter value of each desire, When "ranges (50,100)" of parameter value of "he being "[glad (JOY)]" and surprised (SUPRISE)" or "feeling sad (SADNESS)" is 50-100, it can change to other nodes. [either]

[0046]moreover -- in the state transition table 37 -- "-- others -- a node name which can change from the node $NODE_0$ - $NODE_n$ in a sequence of a "transition destination node" in a column of transition probability" to a node being listed, and. transition probability to each of other node $NODE_0$ which can change when all the conditions described by each line of an "input event name", a "data value", and the "range of data" are met - $NODE_n$ -- "-- others -- it is described by line of "output action" in a column of transition probability" to a node. in addition -- "-- others -- the sum of transition probability of each line in a column of transition probability" to a node -- 100 [%] It has become.

[0047]A case where a recognition result that it carries out "detecting a ball (BALL)", for example, and "ranges (0, 1000)" of "a size (SIZE)" of the ball is 0-1000 in node NODE100 which follows and is expressed in the state transition table 37 of drawing 5 is given "30 [%] It can change to "node NODE120" (node 120) by transition probability which is ", and action at that time "ACTION 1" will be outputted.

[0048]And the behavior model 35 is constituted as a lot of node $NODE_0$ described as such a state transition table 37 - $NODE_n$ are connected. And a time of a recognition result being given to the action determination object 32 from the semantic conversion object 30, When a notice is given from feeling and the instinct generation object 31, it opts for next action and operation probable using the state transition table 37 of corresponding node $NODE_0$ stored in the internal memory memory 16 - $NODE_n$.

[0049]In addition to this composition, in the internal memory memory 16. the correspondence table 38 as shown in drawing 6 as the walk decision information 36 for every emotion of a feeling model in feeling and the instinct generation object 31 -- ******** -- being-izing, and it being stored and, It is made as [determine / a gait pattern of the pet robot 1 / based on these correspondence tables 38 / the action determination object 32 / according to an emotion and its degree].

[0050]That is, in the correspondence table 38 for every emotion, expressions of a gait pattern differ for every emotion, and the level division of the degree of expression of five steps is carried out according to parameter value of each emotion concerned.

[0051]In 0-20, the level J3 and a gait pattern corresponding to the level J5 in the level J4 and the range of 81-100 at the range of 61-80 are set up for parameter value of an emotion which expresses "joy" first the level J2 and in 41-60 the level J1 and in 21-40, respectively. In this case, from the level J1, even to the level J5, gradually, a leg is raised more highly, and one by one, a gait pattern in an emotion showing "joy" is set up so that walk speed may become quick.

[0052]"Sadness." In 0-20, level Sa3 and a gait pattern corresponding to level Sa5 in the range of level Sa4, and 81-100 at the range of 61-80 are set up for parameter value of an

emotion to express in level Sa2, and 41-60 in level Sa1, and 21-40, respectively. In this case, a head is gradually hung down low one by one from level Sa1 to level Sa5, and a gait pattern in an emotion showing "sadness" is set up so that walk speed may become slow.

[0053]In 0-20, level A3 and a gait pattern corresponding to level A5 in level A4 and the range of 81-100 at the range of 61-80 are set up for parameter value of an emotion which furthermore expresses "anger" the level A2 and in 41-60 the level A1 and in 21-40, respectively. in this case -- a gait pattern according to an emotion showing "anger" raises a leg highly gradually one by one from the level A1 to level A5 -- quick -- taking down (it stamps) -- it is set up sway the body violently.

[0054]Furthermore, "surprise." In 0-20, level Su3 and a gait pattern corresponding to level Su5 in the range of level Su4, and 81-100 at the range of 61-80 are set up for parameter value of an emotion to express in level Su2, and 41-60 in level Su1, and 21-40, respectively. in this case, a gait pattern according to an emotion showing "surprise" raises a leg quickly highly gradually one by one from level Su1 to level Su5 (it flies and bounds) -- it is set up like.

[0055]In 0-20, the level H3 and a gait pattern corresponding to the level H5 in the level H4 and the range of 81-100 at the range of 61-80 are set up for parameter value of an emotion which furthermore expresses "dislike" the level H2 and in 41-60 the level H1 and in 21-40, respectively. In this case, a gait pattern according to an emotion showing "dislike" is set up walk late while the level H1 to the level H5 shakes the head at right and left quickly gradually one by one.

[0056]Therefore, the action determination object 32, referring to parameter value of each emotion of a feeling model in feeling and the instinct generation object 31 periodically. After determining a gait pattern of the pet robot 1 selectively according to a kind of the emotion, and a degree of the emotion concerned, After making it reflected in action and operation which determined the determined gait pattern concerned probable using the state transition table 37 of node NODE0 - NODEn mentioned above, it is made as [notify / to the action generating module 33 / these decision results].

[0057]The action generating module 33 so that it may be revealed, making a gait pattern [as which the pet robot 1 was specified / action or operation] according to an emotion and its degree reflect based on a notice from the action determination module 32, Audio signal S9 (drawing 2) which carries out drive controlling of actuator 3AA1 [corresponding if needed] - 5AM, or corresponds is generated, it sends out to the loudspeaker 23 or LED of a position of "eyes" is blinked.

[0058]Thus, in the pet robot 1, Based on data for various control stored in a control program and the internal memory memory 16 which were stored in the enternal memory memory 15, it is made as [perform / a situation of self and the circumference, directions from a user, and autonomous action according to influence].

[0059](4) If the pet robot 1 is in the state where fixed time neglect was carried out when finding it, it is glad, approaching and kicking a ball, while [concrete] the example of an action manifestation (4-1) is loitering, when search avarice and movement avarice go up gradually, the usual gait pattern will be started. If a pink ball is placed in a field of view of CCD camera 21 of the pet robot 1 at this time, the semantic conversion object 30 will obtain a recognition result of a "ball", and will raise parameter value of "joy" in feeling and the instinct generation object 31.

[0060]Since parameter value of joy rose, the action determination object 32 changes a gait pattern into the level J2 which is a somewhat active gait pattern from the usual level J1, and approaches a ball. Since a recognition result of a "ball" is sent to an inside of the pet robot 1 repeatedly as a ball is approached soon, parameter value of joy rises continuously, and it walks, also changing a gait pattern into the more active level J3 and also the level J4.
[0061]And a ball is approached eventually, and when it succeeds in kicking on the ball concerned, parameter value of joy rises further. When joy exceeds a threshold specified in the group of operation, an internal state of joy can be expressed by performing a joy motion corresponding to the threshold also including a process of the change.
[0062](4-2) When a ball is taken and it gets angry, while the pet robot 1 is lying idle with a ball, parameter value of joy is high. However, when a ball kicks itself and it is except suddenly lost from the inside of a field of view of CCD camera 21, while parameter value of joy descends, parameter value of surprise rises. At this time, the pet robot 1 performs operation which looks for a ball, after operating surprise, but when a ball is not found in a field of view beyond as for fixed time, parameter value of anger rises gradually.
[0063]Since parameter value of anger rose, the action determination object 32 stamps, changing a gait pattern into the level A2, A3, and A4 one by one from the usual level A1, and it continues swaying the body violently. When parameter value of anger rises and it results in level A5, without still finding a ball, a dance of anger is performed on that spot.
[0064]By operating anger in this way, operation of anger is suspended and it decreases in time. Also when decreasing, a gait pattern is changed one by one with level A3, A2, and A1. When parameter value of other emotions rises by the middle, a gait pattern according to parameter value of the emotion is chosen according to a degree of the emotion.
[0065](5) In operation by this embodiment, and composition beyond an effect, based on influence from a surrounding situation and a user, choose the next action from the present state and it is revealed with this pet robot 1. When changing from a state as of this time to the next action and change of an emotion showing feeling of the pet robot 1 is comparatively loose (for example, when looking for a case where a ball is approached, and a ball etc.), The sequential selection of the gait pattern according to a kind of the emotion and its degree is made, and each selected gait pattern concerned is made to express a process of change of this emotion.
[0066]Therefore, in this pet robot 1, a gait pattern can be changed according to change of feeling in a specific phenomenon.
[0067]According to the above composition, by having made it change a gait pattern according to change of feeling in a specific phenomenon, much more sense of closeness and satisfaction are given to a user, and a pet robot which may raise amusement nature markedly can be realized with this pet robot 1.
[0068](6) they are other embodiments -- although a case where it was made to apply to the quadrapedalism type pet robot 1 constituted like drawing 1 in an above-mentioned embodiment was described -- this invention -- not only this -- in addition, it is widely applicable to a robot of a walking type of various composition.
[0069]In this case, although an above-mentioned embodiment described a case where the controller 10 and each actuator $3AA_1$ - 5_M, etc. were applied, as a driving means which drives two or more legs 3A - 3D, In addition to this according to a gestalt of a robot device which applies this invention as a driving means, various composition is applicable.

[0070]In an above-mentioned embodiment, described a case where a control means which controls a driving means was constituted from the controller 10 so that a pattern of a walk might be changed according to a degree of an emotion according to a feeling model, but. In addition to this, this invention can apply various composition according to a gestalt of not only this but a robot device which applies this invention as a control means.

[0071]Although a case where a gait pattern of the pet robot 1 was set [for every emotion] up using the correspondence table 38, respectively on five steps of levels according to the degree was described in a further above-mentioned embodiment, It may be made for this invention to set up two or more steps (2-4 steps or six steps or more) of levels according to a kind of not only this but emotion, and its degree.

[0072]In this case, although a motion of each leg unit 3A - 3D was patternized as a gait pattern in an above-mentioned embodiment, In addition to a motion of each leg unit 3A concerned - 3D, a motion of the head unit 4 and the tail part unit 5 is also patternized, and it may be made to make it change gradually according to a degree of an emotion.

[0073]In a further above-mentioned embodiment, a gait pattern of the pet robot 1, Although the file-ized correspondence table 38 is stored in the internal memory memory 16 and a case where a gait pattern corresponding to a kind of emotion and its degree was chosen from the correspondence table 38 concerned was described, As long as this invention can change a gait pattern, corresponding [not only this but] to change of an emotion in short, it may be made to change a gait pattern, as it makes an angle parameter, a kinetic parameter, an acceleration parameter, etc. change according to change of an emotion.

[0074]For example, as a method of making an angle parameter changing, the action determination object 32 has a parameter according to a feeling model which changes a joint angle and angle of rotation of each leg unit 3A - 3D of the pet robot 1 for every emotion, respectively.

[0075]The action determination object 32 is actually a following formula as minimum angle $theta_0$ of a joint which rotates a coefficient value showing sensitivity beforehand set up to parameter value $E_{(n)}$ of a given period of the emotion, and its emotion about each emotion at the time of a k_r usual walk. [0076]

[Equation 3]

$$\theta_{(n)} = E_{(n)} * k_r + \theta_0 \qquad \cdots\cdots (3)$$

[0077]It is alike, joint angle $theta_{(n)}$ of each leg unit 3A according to the emotion - 3D is computed more, and each leg unit 3A - 3D are operated by joint angle $theta_{(n)}$ according to the emotion.

[0078]If the pet robot 1 finds a ball in the field of view of CCD camera 21 first when finding it, it is glad, and approaching and kicking a pink ball, while the pet robot 1 is carrying out loiteringly concretely, The semantic conversion object 30 obtains the recognition result of a "ball", and raises the parameter value of "joy" in feeling and the instinct generation object 31.

[0079]Since parameter value of joy rose, the action determination object 32 is each 2nd joint of both front leg part units 3A and 3B 10 [**] By changing into parameter value of moving greatly, both front leg part units 3A and 3B are changed into a walk raised somewhat highly, and a ball is approached depending on a more active way of walking.

[0080]Since a recognition result of a ball is sent to an inside of the pet robot 1 repeatedly as a ball is approached soon, parameter value of joy continues rising, and it is each 1st joint of both hind leg part unit 3Cs and 3D 10 [**] By changing into parameter value moved greatly, it becomes the walk which moves more greatly both not only front leg part units 3A and 3B but both hind leg part unit 3Cs and 3D, and a much more active walk is carried out.
[0081]And a ball is approached eventually, and when it succeeds in kicking on the ball concerned, parameter value of joy rises further. When joy exceeds a threshold specified in the group of operation, an internal state of joy can be expressed by performing a joy motion corresponding to the threshold also including a process of the change.
[0082]
[Effect of the Invention]In the robot device which has two or more legs, and walks it with a prescribed pattern according to this invention as mentioned above as drives each leg, By having made it provide with the driving means which drives each leg, and the control means which controls a driving means to change the pattern of a walk according to the degree of an emotion according to a feeling model, The robot device which can change a gait pattern according to change of feeling in a specific phenomenon, and may raise amusement nature markedly in this way is realizable.
[0083]In the control method of a robot device of according to this invention having two or more legs, and walking it with a prescribed pattern as each leg is driven, By having made it drive each leg so that the pattern of a walk may be changed according to the degree of an emotion according to a feeling model, The control method of the robot device which can change a gait pattern according to change of feeling in a specific phenomenon, and may raise amusement nature markedly in this way is realizable.
[0084].

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention]This invention is applied to a pet robot, concerning a robot device and a method for controlling the same, and is preferred.

[Translation done.]

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PRIOR ART

[Description of the Prior Art]In recent years, the quadrapedalism type pet robot which performs operation regular according to the environment of the instructions from a user or the circumference is proposed and developed by this application applicant for a patent. This pet robot has the shape similar to the dog bred in an ordinary home, or a cat, and operates according to the instructions from a user, the surrounding environment, etc.

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EFFECT OF THE INVENTION

[Effect of the Invention]In the robot device which has two or more legs, and walks it with a prescribed pattern by this invention as mentioned above as drives each leg, It was made to provide with the driving means which drives each leg, and the control means which controls a driving means to change the pattern of a walk according to the degree of an emotion according to a feeling model.
Therefore, the robot device which can change a gait pattern according to change of feeling in a specific phenomenon, and may raise amusement nature markedly in this way is realizable.

[0083]It has two or more legs and was made to drive each leg in this invention, in the control method of a robot device of walking it with a prescribed pattern as each leg is driven, so that the pattern of a walk may be changed according to the degree of an emotion according to a feeling model.
Therefore, the control method of the robot device which can change a gait pattern according to change of feeling in a specific phenomenon, and may raise amusement nature markedly in this way is realizable.

[0084].

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]By the way, when it has a function which expresses various feeling according to the influence from a surrounding situation and user in this pet robot, expressing a rapid change of feeling comparatively for a short time is performed, but. If change of the loose feeling that time is needed further comparatively can be expressed based on the process, the much more sense of closeness and satisfaction will be given to a user, and it will be thought that the amusement nature as a pet robot can be raised more.
[0004]If a loose change of such feeling can be especially expressed using the gait pattern of a pet robot, it will be easy to recognize the process in which the emotional expression of a pet robot changes for a user, and it will be thought that diversity can be given to those expressions.
[0005]This invention was made in consideration of the above point, and tends to propose a robot device which may raise amusement nature markedly, and a method for controlling the same.

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MEANS

[Means for Solving the Problem]In [in order to solve this technical problem] this invention, It has two or more legs and was made to provide in a robot device which walks it with a prescribed pattern as drives each leg with a driving means which drives each leg, and a control means which controls a driving means to change a pattern of a walk according to a degree of an emotion according to a feeling model.
[0007]As a result with this pet robot, a gait pattern can be changed according to change of feeling in a specific phenomenon.
[0008]It has two or more legs and was made to drive each leg in this invention, in a control method of a robot device of walking it with a prescribed pattern as each leg is driven, so that a pattern of a walk may be changed according to a degree of an emotion according to a feeling model.
[0009]As a result with this pet robot, a gait pattern can be changed according to change of feeling in a specific phenomenon.
[0010]
[Embodiment of the Invention]About a drawing, the 1 embodiment of this invention is explained in full detail below.
[0011](1) In the lineblock diagram 1 of the pet robot by this embodiment, the pet robot by this embodiment is shown as a whole, and the leg unit 3A - 3D are connected with front and rear, right and left of the idiosoma unit 2, respectively, and 1. It is constituted by connecting the head unit 4 and the tail part unit 5 with the front end part and rear end part of the idiosoma unit 2, respectively.
[0012]A cooling fan (not shown) is formed in the inside of this idiosoma unit 2, and exhaust-port 2AX and an inlet port (not shown) are formed in the upper surface 2A and undersurface 2B via the cooling fan concerned, respectively. Thereby, with the pet robot 1, according to the drive of a cooling fan, as the air inhaled from the inlet port is discharged outside from exhaust-port 2AX via the inside of the idiosoma unit 2, it is made as [reduce / the internal temperature of the idiosoma unit 2 concerned].
[0013](2) the internal configuration of a pet robot system -- to the idiosoma unit 2 in the pet robot 1 shown in drawing 2 here. The controller 10 which controls operation of this pet robot 1 whole, and the battery 11 used as the source of power of this pet robot 1, The internal sensor part 14 which consists of the battery sensor 12 and the heat sensor 13, the information reading part 17 to which the enternal memory memory 15 and the internal memory memory 16 were connected, and the acceleration sensor 18 and the angular velocity sensor 19 are stored.

[0014]The microphone 20 which is equivalent to an "ear" at the head unit 4 and the CCD (Charge Coupled Device) camera 21 equivalent to "eyes", The touch sensor 22, the loudspeaker 23 equivalent to a "mouth", the distance sensors 24 that become by an infrared distance sensor etc., etc. are allocated in the prescribed position, respectively.
[0015]Furthermore, the joint portion of each leg unit 3A - 3D, and each joining segment of each leg unit 3A - 3D, and the idiosoma unit 2, To the joining segment of the joining segment of the head unit 4 and the idiosoma unit 2, the tail part unit 5, and the idiosoma unit 2, respectively Actuator $3AA_1$ - $3AA_K$, $3BA_1$ - $3BA_K$, $3CA_1$ - $3CA_K$, $3DA_1$ - $3DA_K$, $4A_1$ - $4A_L$, $5A_1$ - $5A_M$ are allocated. And the microphone 20 of the head unit 4, The audio signal S1 acquired by collecting the instruction sound given as a scale by the sound commander (commander who generates the sound of a different scale according to the contents of operation) who does not illustrate from a user, such as "walk", "lie down", or "pursue a ball", is sent out to the controller 10. CCD camera 21 sends out the picture signal S2 acquired by picturizing the situation of front to the controller 10, and the distance sensors 24 measure the distance to a front subject, and it sends them out to the controller 10 by making the measurement result concerned into the range measurement signal S3.
[0016]Furthermore, in drawing 1, the touch sensor 22 is formed in the upper part of the head unit 4 so that clearly, it detects the pressure were pressured by "it strokes" and the physical influence of "striking" from a user, and sends it out to the controller 10 by making a detection result into pressure detection signal S4.
[0017]Furthermore, the battery sensor 12 of the idiosoma unit 2 divides the residue of the battery 11 into two or more steps, detects it, and sends it out to the controller 10 one by one by making the detection result of each stage concerned into the battery residual quantity detecting signal S5.
[0018]Furthermore, the heat sensor 13 of the idiosoma unit 2 detects the internal temperature of the pet robot 1, and sends it out to the controller 10 by making the detection result concerned into the heat detecting signal S6.
[0019]Furthermore, the acceleration sensor 18 of the idiosoma unit 2 detects the acceleration of the direction of 3 axes (the X-axis, a Y-axis, Z-axis) per tens of milliseconds, respectively, and sends it out to the controller 10 by making the detection result concerned into the acceleration detecting signal S7. The angular velocity sensor 19 detects the angular rate of rotation of 3 each (R angle, P angle, Y angle) direction per tens of milliseconds, and sends it out to the controller 10 by making the detection result concerned into the angular velocity detecting signal S8.
[0020]The controller 10, The audio signal S1 and the picture signal S2 which are given from the microphone 20, CCD camera 21, the distance sensors 24, the touch sensor 22, the battery sensor 12, the heat sensor 13, the acceleration sensor 18, and the angular velocity sensor 19, the range measurement signal S3, pressure detection signal S4, the battery residual quantity detecting signal S5, Based on the heat detecting signal S6, the acceleration detecting signal S7, the angular velocity detecting signal S8, etc., existence, such as the surrounding situation, instructions from a user, influence from a user, is judged.
[0021]And the controller 10 opts for the action which continues based on the control program inputted via the information reading part 17 from this decision result and the enternal memory memory 15, Based on decision results, required actuator $3AA_1$ - $3AA_K$,

By making $3BA_1$ - $3BA_K$, $3CA_1$ - $3CA_K$, $3DA_1$ - $3DA_K$, $4A_1$ - $4A_L$, $5A_1$ - $5A_M$ drive, Action and operation of the head unit 4 being made to be able to shake vertically and horizontally, being able to move the tail part unit 5, or driving and walking him around each leg unit 3A - 3D are made to perform. A set of operation shall be used for below, defining it as action.

[0022]In this case, the controller 10 makes the sound based on the audio signal S9 concerned output outside by giving predetermined audio signal S9 to the loudspeaker 23 if needed, or. LED (Light Emitting Diode) which was provided in the position of the "eye" of this pet robot 1 and which is not illustrated is turned on, switched off or blinked.

[0023]Thus, in this pet robot 1, it is made as [act / based on a surrounding situation, a control program etc. / it / autonomously].

[0024]The enternal memory memory 15 in the idiosoma unit 2 becomes with recording media, such as a memory stick which can be inserted from the exterior, and the control program mentioned above about the pet robot 1 whole is beforehand stored in the recording medium concerned. Furthermore, it is stored in the internal memory memory 16 in the state where hardware information, calibration information, an error operation execution program, learning information, personal information, etc. are rewritable. Various kinds of programs and information which are stored in these enternal memory memory 15 and the internal memory memory 16 are made as [write / according to control of the controller 10 / reading and the information reading part 17].

[0025]By this the controller 10 by opting for action of the pet robot 1 based on various kinds of programs and information which were read from the enternal memory memory 15 and the internal memory memory 16 by the information reading part 17, Corresponding to the determination concerned, required address $3AA_1$ - $5A_M$ are driven, and it is made as [output / if needed / from the loudspeaker 23 / a sound].

[0026]Thus, in this pet robot 1, it is made as [change / autonomous action of the pet robot 1 / with personality] according to various kinds of programs and information which are stored in the enternal memory memory 15 and the internal memory memory 16.

[0027](3) the software configuration of a control program -- here shows the software configuration of the above-mentioned control program in the pet robot 1 to drawing 3. The control program comprises the semantic conversion object 30, feeling and an instinct generation object 31, the action determination object 32, and the action generation object 33 so that clearly also from this drawing 3.

[0028]In this case, the semantic conversion object 30, The audio signal S1 given from the microphone 20, the picture signal S2 given from CCD camera 21, the range measurement signal S3 given from the distance sensors 24, pressure detection signal S4 given from the touch sensor 22, the acceleration detecting signal S7 given from the acceleration sensor 18, And based on the angular velocity detecting signal S8 given from the angular velocity sensor 19, recognize existence, such as a state around the pet robot 1, instructions from a user, a user's influence, and. Based on the battery residual quantity detecting signal S5 and the heat detecting signal S6 which are given from the battery sensor 12 and the heat sensor 13 which constitute the internal sensor 14, After recognizing the residue state of the battery 11, and the internal temperature of the pet robot 1, these recognition results are notified to feeling, the instinct generation object 31, and the action determination object 32.

[0029]The recognition result to which feeling and the instinct generation object 31 are

given from the semantic conversion object 30, Based on the personal information 34 stored in the internal memory memory 16, and the notice showing the performed action which is given from the action determination object 32 like the after-mentioned, the feeling of the pet robot 1 and the state of instinct are determined, When the state of the feeling concerned and instinct exceeds a predetermined level, this is notified to the action determination object 32.

[0030]That is, feeling and the instinct generation object 31 are provided with the following.

The feeling model holding a total of six parameters with which the strength of each emotion of "joy", "sadness", "anger", "surprise", "fear", and "dislike" is expressed, respectively.

The instinct model holding a total of four parameters with which the strength of each desire of "love avarice", "search avarice", "movement avarice", and "appetite" is expressed, respectively.

[0031]As the personal information 34, when "being struck" by the internal memory memory 16, for example, raise the parameter of "anger" to it, and the parameter of "joy" is lowered to it, When "stroked", raise the parameter of "joy", and the parameter of "anger" is lowered, When a certain action is revealed, raise the parameter of "movement avarice", and the parameter of "joy" The recognition result of ********** and the semantic conversion object 30, The data the value of which emotion or the parameter of desire to increase or decrease to the notice of having performed action from the below-mentioned action generation object 33 is stored.

[0032]And feeling and the instinct generation object 31 change the value of the emotion or the parameter of desire with which a feeling model or an instinct model corresponds periodically based on the recognition result given from the semantic conversion object 30, the notice from the action determination object 32, etc. based on personal information.

[0033]More specifically feeling and the instinct generation object 31, The coefficient value showing the sensitivity beforehand set up to P and its emotion in the numerical value acquired by a predetermined operation about each emotion based on the notice content from a recognition result and the action determination object 32 to which the parameter value in front of 1 cycle of the emotion was given into $E_{(n-1)}$ and its cycle is set to ke, and it is a following formula. [0034]

[Equation 1]

$$E_{(n)} = k_e * P + E_{(n-1)} \quad \cdots\cdots (1)$$

[0035]It is alike, parameter value $E_{(n)}$ of the next cycle of that emotion is computed more, and the parameter value of that emotion is changed into this parameter value $E_{(n)}$.

[0036]Feeling and the instinct generation object 31 the parameter value in front of 1 cycle of the desire about each desire $I_{(n-1)}$, The coefficient value showing the sensitivity beforehand set up to Q and its desire in the numerical value acquired by a predetermined operation based on the notice content from a recognition result and the action determination object 32 given into the cycle is set to ki, and it is a following formula.

[0037]

[Equation 2]

$$I_{(n)} = k_i * Q + I_{(n-1)} \quad \cdots\cdots (2)$$

[0038]It is alike, parameter value $I_{(n)}$ of the next cycle of that desire is computed more, and the parameter value of that desire is changed into this parameter value $I_{(n)}$.
[0039]And feeling and the instinct generation object 31 notify this to the action determination object 32, when the parameter value of one of emotions or the parameter of desire exceeds the value beforehand set up to the emotion or instinct as a result of the update process of such each parameter value.
[0040]The recognition result to which the action determination object 32 is given from the semantic conversion object 30, It opts for the action which continues based on the notice from feeling and the instinct generation object 31, and the behavior model 35 and the walk decision information 36 which are stored in the internal memory memory 16, and decision results are notified to the action generation object 23.
[0041]In the case of this embodiment, the action determination object 32, As the technique of opting for the next action, One node as shown in drawing 4. (State) As opposed to arc ARC_1 which connects between each node $NODE_0$ - $NODE_n$ for to other node $NODE_0$ of which - $NODE_n$ it changes from $NODE_0$ - $NODE_n$ - ARC_{n+1}. The algorithm called the probabilistic automaton determined probable based on transition probability P_1 set up, respectively - P_{n+1} is used.
[0042]The state transition table 37 as shown in drawing 5 for every node $NODE_0$ - $NODE_n$ as the behavior model 35 is more specifically stored in the internal memory memory 16, It is made as [set / the action determination object 32 / action which continues based on these state transition tables 37].
[0043]Namely, in the state transition table 37, an input event (recognition result) made into transition conditions in the node $NODE_0$ - $NODE_n$ is listed by line of an "input event" at a priority, Further conditions about the transition condition are described by a "data name" and corresponding sequence in a line of a "data range."
[0044]Therefore, in node NODE100 expressed in a state transition table of drawing 5. When a recognition result of "detecting a ball (BALL)" is given, "A range (0, 1000)" of "a size (SIZE)" of the ball given with the recognition result concerned is 0 to 1000, When a recognition result of "detecting an obstacle (OBSTACLE)" is given, they have been conditions for that "ranges (0,100)" of "distance (DISTANCE)" to the obstacle done with the recognition result concerned is 0-100 to change to other nodes.
[0045]Also in a case where there is no input of a recognition result this node NODE100, Inside of each emotion of a feeling model in feeling and an instinct generation object which an action determination object refers to periodically, and an instinct model, and parameter value of each desire, When "ranges (50,100)" of parameter value of "he being "[glad (JOY)]" and surprised (SUPRISE)" or "feeling sad (SADNESS)" is 50-100, it can change to other nodes. [either]
[0046]moreover -- in the state transition table 37 -- "-- others -- a node name which can change from the node $NODE_0$ - $NODE_n$ in a sequence of a "transition destination node" in a column of transition probability" to a node being listed, and. transition probability to each of other node $NODE_0$ which can change when all the conditions described by each line of an "input event name", a "data value", and the "range of data" are met - $NODE_n$ -- "-- others -- it is described by line of "output action" in a column of transition probability" to a node. in addition -- "-- others -- the sum of transition probability of each

line in a column of transition probability" to a node -- 100 [%] It has become.
[0047]A case where a recognition result that it carries out "detecting a ball (BALL)", for example, and "ranges (0, 1000)" of "a size (SIZE)" of the ball is 0-1000 in node NODE100 which follows and is expressed in the state transition table 37 of drawing 5 is given "30 [%] It can change to "node NODE120" (node 120) by transition probability which is ", and action at that time "ACTION 1" will be outputted.
[0048]And the behavior model 35 is constituted as a lot of node $NODE_0$ described as such a state transition table 37 - $NODE_n$ are connected. And a time of a recognition result being given to the action determination object 32 from the semantic conversion object 30, When a notice is given from feeling and the instinct generation object 31, it opts for next action and operation probable using the state transition table 37 of corresponding node $NODE_0$ stored in the internal memory memory 16 - $NODE_n$.
[0049]In addition to this composition, in the internal memory memory 16. the correspondence table 38 as shown in drawing 6 as the walk decision information 36 for every emotion of a feeling model in feeling and the instinct generation object 31 -- ******** -- being-izing, and it being stored and, It is made as [determine / a gait pattern of the pet robot 1 / based on these correspondence tables 38 / the action determination object 32 / according to an emotion and its degree].
[0050]That is, in the correspondence table 38 for every emotion, expressions of a gait pattern differ for every emotion, and the level division of the degree of expression of five steps is carried out according to parameter value of each emotion concerned.
[0051]In 0-20, the level J3 and a gait pattern corresponding to the level J5 in the level J4 and the range of 81-100 at the range of 61-80 are set up for parameter value of an emotion which expresses "joy" first the level J2 and in 41-60 the level J1 and in 21-40, respectively. In this case, from the level J1, even to the level J5, gradually, a leg is raised more highly, and one by one, a gait pattern in an emotion showing "joy" is set up so that walk speed may become quick.
[0052]"Sadness." In 0-20, level Sa3 and a gait pattern corresponding to level Sa5 in the range of level Sa4, and 81-100 at the range of 61-80 are set up for parameter value of an emotion to express in level Sa2, and 41-60 in level Sa1, and 21-40, respectively. In this case, a head is gradually hung down low one by one from level Sa1 to level Sa5, and a gait pattern in an emotion showing "sadness" is set up so that walk speed may become slow.
[0053]In 0-20, level A3 and a gait pattern corresponding to level A5 in level A4 and the range of 81-100 at the range of 61-80 are set up for parameter value of an emotion which furthermore expresses "anger" the level A2 and in 41-60 the level A1 and in 21-40, respectively. in this case -- a gait pattern according to an emotion showing "anger" raises a leg highly gradually one by one from the level A1 to level A5 -- quick -- taking down (it stamps) -- it is set up sway the body violently.
[0054]Furthermore, "surprise." In 0-20, level Su3 and a gait pattern corresponding to level Su5 in the range of level Su4, and 81-100 at the range of 61-80 are set up for parameter value of an emotion to express in level Su2, and 41-60 in level Su1, and 21-40, respectively. in this case, a gait pattern according to an emotion showing "surprise" raises a leg quickly highly gradually one by one from level Su1 to level Su5 (it flies and bounds) -- it is set up like.
[0055]In 0-20, the level H3 and a gait pattern corresponding to the level H5 in the level

H4 and the range of 81-100 at the range of 61-80 are set up for parameter value of an emotion which furthermore expresses "dislike" the level H2 and in 41-60 the level H1 and in 21-40, respectively. In this case, a gait pattern according to an emotion showing "dislike" is set up walk late while the level H1 to the level H5 shakes the head at right and left quickly gradually one by one.

[0056]Therefore, the action determination object 32, referring to parameter value of each emotion of a feeling model in feeling and the instinct generation object 31 periodically. After determining a gait pattern of the pet robot 1 selectively according to a kind of the emotion, and a degree of the emotion concerned, After making it reflected in action and operation which determined the determined gait pattern concerned probable using the state transition table 37 of node NODE0 - NODEn mentioned above, it is made as [notify / to the action generating module 33 / these decision results].

[0057]The action generating module 33 so that it may be revealed, making a gait pattern [as which the pet robot 1 was specified / action or operation] according to an emotion and its degree reflect based on a notice from the action determination module 32, Audio signal S9 (drawing 2) which carries out drive controlling of actuator 3AA1 [corresponding if needed] - 5AM, or corresponds is generated, it sends out to the loudspeaker 23 or LED of a position of "eyes" is blinked.

[0058]Thus, in the pet robot 1, Based on data for various control stored in a control program and the internal memory memory 16 which were stored in the enternal memory memory 15, it is made as [perform / a situation of self and the circumference, directions from a user, and autonomous action according to influence].

[0059](4) If the pet robot 1 is in the state where fixed time neglect was carried out when finding it, it is glad, approaching and kicking a ball, while [concrete] the example of an action manifestation (4-1) is loitering, when search avarice and movement avarice go up gradually, the usual gait pattern will be started. If a pink ball is placed in a field of view of CCD camera 21 of the pet robot 1 at this time, the semantic conversion object 30 will obtain a recognition result of a "ball", and will raise parameter value of "joy" in feeling and the instinct generation object 31.

[0060]Since parameter value of joy rose, the action determination object 32 changes a gait pattern into the level J2 which is a somewhat active gait pattern from the usual level J1, and approaches a ball. Since a recognition result of a "ball" is sent to an inside of the pet robot 1 repeatedly as a ball is approached soon, parameter value of joy rises continuously, and it walks, also changing a gait pattern into the more active level J3 and also the level J4.

[0061]And a ball is approached eventually, and when it succeeds in kicking on the ball concerned, parameter value of joy rises further. When joy exceeds a threshold specified in the group of operation, an internal state of joy can be expressed by performing a joy motion corresponding to the threshold also including a process of the change.

[0062](4-2) When a ball is taken and it gets angry, while the pet robot 1 is lying idle with a ball, parameter value of joy is high. However, when a ball kicks itself and it is except suddenly lost from the inside of a field of view of CCD camera 21, while parameter value of joy descends, parameter value of surprise rises. At this time, the pet robot 1 performs operation which looks for a ball, after operating surprise, but when a ball is not found in a field of view beyond as for fixed time, parameter value of anger rises gradually.

[0063]Since parameter value of anger rose, the action determination object 32 stamps,

changing a gait pattern into the level A2, A3, and A4 one by one from the usual level A1, and it continues swaying the body violently. When parameter value of anger rises and it results in level A5, without still finding a ball, a dance of anger is performed on that spot.
[0064]By operating anger in this way, operation of anger is suspended and it decreases in time. Also when decreasing, a gait pattern is changed one by one with level A3, A2, and A1. When parameter value of other emotions rises by the middle, a gait pattern according to parameter value of the emotion is chosen according to a degree of the emotion.
[0065](5) In operation by this embodiment, and composition beyond an effect, based on influence from a surrounding situation and a user, choose the next action from the present state and it is revealed with this pet robot 1. When changing from a state as of this time to the next action and change of an emotion showing feeling of the pet robot 1 is comparatively loose (for example, when looking for a case where a ball is approached, and a ball etc.), The sequential selection of the gait pattern according to a kind of the emotion and its degree is made, and each selected gait pattern concerned is made to express a process of change of this emotion.
[0066]Therefore, in this pet robot 1, a gait pattern can be changed according to change of feeling in a specific phenomenon.
[0067]According to the above composition, by having made it change a gait pattern according to change of feeling in a specific phenomenon, much more sense of closeness and satisfaction are given to a user, and a pet robot which may raise amusement nature markedly can be realized with this pet robot 1.
[0068](6) they are other embodiments -- although a case where it was made to apply to the quadrapedalism type pet robot 1 constituted like drawing 1 in an above-mentioned embodiment was described -- this invention -- not only this -- in addition, it is widely applicable to a robot of a walking type of various composition.
[0069]In this case, although an above-mentioned embodiment described a case where the controller 10 and each actuator $3AA_1$ - 5_M, etc. were applied, as a driving means which drives two or more legs 3A - 3D, In addition to this according to a gestalt of a robot device which applies this invention as a driving means, various composition is applicable.
[0070]In an above-mentioned embodiment, described a case where a control means which controls a driving means was constituted from the controller 10 so that a pattern of a walk might be changed according to a degree of an emotion according to a feeling model, but. In addition to this, this invention can apply various composition according to a gestalt of not only this but a robot device which applies this invention as a control means.
[0071]Although a case where a gait pattern of the pet robot 1 was set [for every emotion] up using the correspondence table 38, respectively on five steps of levels according to the degree was described in a further above-mentioned embodiment, It may be made for this invention to set up two or more steps (2-4 steps or six steps or more) of levels according to a kind of not only this but emotion, and its degree.
[0072]In this case, although a motion of each leg unit 3A - 3D was patternized as a gait pattern in an above-mentioned embodiment, In addition to a motion of each leg unit 3A concerned - 3D, a motion of the head unit 4 and the tail part unit 5 is also patternized, and it may be made to make it change gradually according to a degree of an emotion.
[0073]In a further above-mentioned embodiment, a gait pattern of the pet robot 1, Although the file-ized correspondence table 38 is stored in the internal memory memory

16 and a case where a gait pattern corresponding to a kind of emotion and its degree was chosen from the correspondence table 38 concerned was described, As long as this invention can change a gait pattern, corresponding [not only this but] to change of an emotion in short, it may be made to change a gait pattern, as it makes an angle parameter, a kinetic parameter, an acceleration parameter, etc. change according to change of an emotion.

[0074]For example, as a method of making an angle parameter changing, the action determination object 32 has a parameter according to a feeling model which changes a joint angle and angle of rotation of each leg unit 3A - 3D of the pet robot 1 for every emotion, respectively.

[0075]The action determination object 32 is actually a following formula as minimum angle $theta_0$ of a joint which rotates a coefficient value showing sensitivity beforehand set up to parameter value $E_{(n)}$ of a given period of the emotion, and its emotion about each emotion at the time of a k_r usual walk. [0076]

[Equation 3]

$$\theta_{(n)} = E_{(n)} * k_r + \theta_0 \quad \cdots\cdots (3)$$

[0077]It is alike, joint angle $theta_{(n)}$ of each leg unit 3A according to the emotion - 3D is computed more, and each leg unit 3A - 3D are operated by joint angle $theta_{(n)}$ according to the emotion.

[0078]If the pet robot 1 finds a ball in the field of view of CCD camera 21 first when finding it, it is glad, and approaching and kicking a pink ball, while the pet robot 1 is carrying out loiteringly concretely, The semantic conversion object 30 obtains the recognition result of a "ball", and raises the parameter value of "joy" in feeling and the instinct generation object 31.

[0079]Since parameter value of joy rose, the action determination object 32 is each 2nd joint of both front leg part units 3A and 3B 10 [**] By changing into parameter value of moving greatly, both front leg part units 3A and 3B are changed into a walk raised somewhat highly, and a ball is approached depending on a more active way of walking.

[0080]Since a recognition result of a ball is sent to an inside of the pet robot 1 repeatedly as a ball is approached soon, parameter value of joy continues rising, and it is each 1st joint of both hind leg part unit 3Cs and 3D 10 [**] By changing into parameter value moved greatly, it becomes the walk which moves more greatly both not only front leg part units 3A and 3B but both hind leg part unit 3Cs and 3D, and a much more active walk is carried out.

[0081]And a ball is approached eventually, and when it succeeds in kicking on the ball concerned, parameter value of joy rises further. When joy exceeds a threshold specified in the group of operation, an internal state of joy can be expressed by performing a joy motion corresponding to the threshold also including a process of the change.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a perspective view showing the appearance composition of the pet robot by this embodiment.
[Drawing 2]It is a block diagram showing the circuitry of the pet robot by this embodiment.
[Drawing 3]It is a block diagram showing the software configuration of a pet robot.
[Drawing 4]It is a key map showing a probabilistic automaton.
[Drawing 5]It is a key map showing a state transition table.
[Drawing 6]It is a key map showing the correspondence table showing a walk parameter.
[Description of Notations]
1 .... A pet robot, 2 .... An idiosoma unit, 3A - 3D .... Leg unit, $3AA_1$ - $5A_M$ .... An actuator, 4 .... Head unit, 5 .... A tail part unit, 10 .... A controller, 12 ---- Battery sensor, 13 .... A heat sensor, 15 .... An enternal memory memory, 16 .... Internal memory memory, 20 .... A microphone, 21 .... A CCD camera, 22 ---- Touch sensor, 23 .... A loudspeaker, 24 .... Distance sensors, 30 ---- Semantic conversion object, 31 [.... Personal information, 35 / .... A behavior model, 36 / .... Walk decision information, 37 / .... A state transition table, 38 / .... Correspondence table.] .... Feeling and an instinct generation object, 32 .... An action determination object, 33 .... An action generation object, 34

[Translation done.]

* NOTICES *

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DRAWINGS

[Drawing 1]

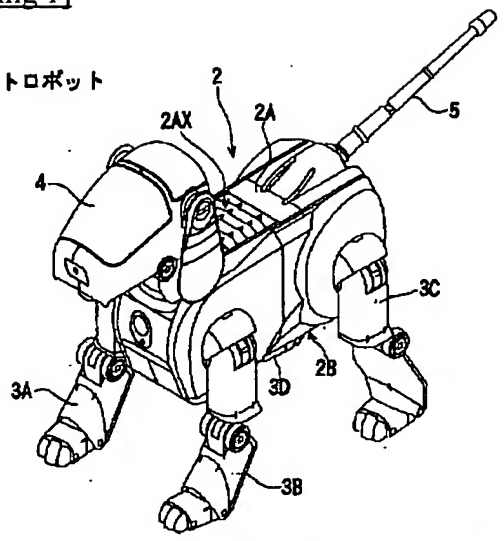

図1　本実施の形態によるペットロボットの構成

[Drawing 2]

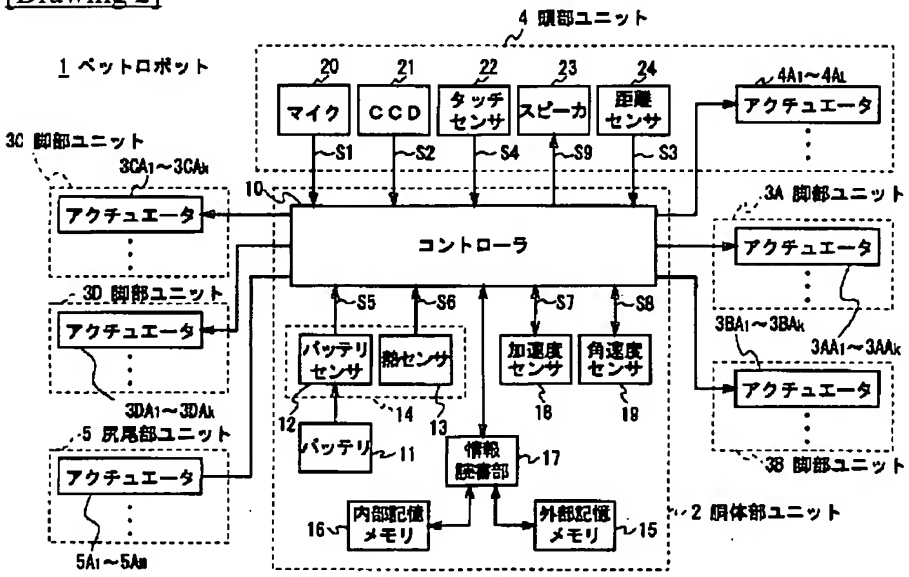

図2　ペットロボットの内部構成

[Drawing 3]

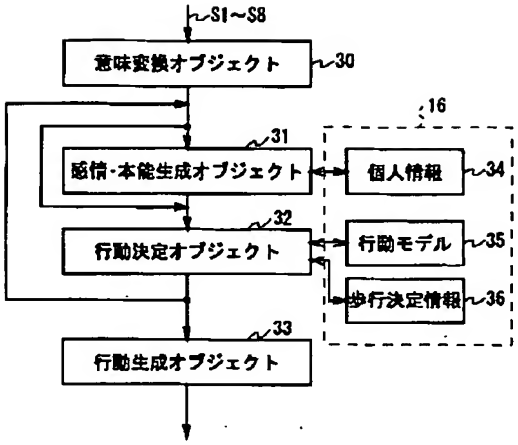

図３　ペットロボットの行動生成

[Drawing 4]

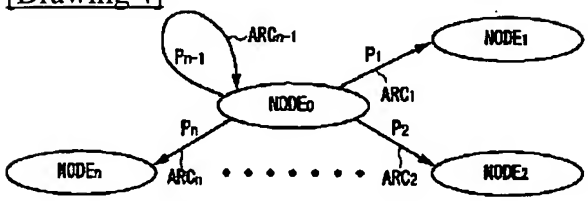

図４　確率オートマトン

[Drawing 5]

NODE100　　NODE120

node 100	入力ｲﾍﾞﾝﾄ名	ﾃﾞｰﾀ名	ﾃﾞｰﾀの範囲	他のﾉｰﾄﾞへの遷移確率 Di				
遷移先ﾉｰﾄﾞ				node 120	node120	node 1000		node 600
出力行動				ACTION 1	ACTION 2	MOVE BACK		ACTION 4
1	BALL	SIZE	0.1000	30%				
2	PAT				40%			
3	HIT				20%			
4	MOTION					50%		
5	OBSTACLE	DISTANCE	0.100			100%		
6		JOY	50.100					
7		SUPRISE	50.100					
8		SADNESS	50.100					

37

図５　状態遷移表

[Drawing 6]

パラメータ値 / 情動の種類	0～20	21～40	41～60	61～80	81～100
喜び	J1	J2	J3	J4	J5
悲しみ	Sa1	Sa2	Sa3	Sa4	Sa5
怒り	A1	A2	A3	A4	A5
驚き	Su1	Su2	Su3	Su4	Su5
恐怖	F1	F2	F3	F4	F5
嫌悪	H1	H2	H3	H4	H5

38

図６　各情動ごとの歩行パターンを表す対応テーブル

[Translation done.]